SCIENCE EDUCATION

NARST NUMBER

GEORGE GREISEN MALLINSON

E. LAURENCE PALMER

RECENTLY ELECTED MEMBERS OF NARST

EVALUATION OF SCIENCE IN GENERAL EDUCATION AT THE COLLEGE LEVEL

APPLYING BIOLOGICAL PRINCIPLES TO PHYSICAL SCIENCES

TEST ITEMS AND CURRICULUM BACKGROUND INFLUENCE RESULTS IN EVALUATING LEARNING

A SYNTHESIS AND EVALUATION OF OBJECTIVES FOR A COURSE IN COLLEGE BIOLOGY

FACTORS OF EFFECTIVENESS IN SCIENCE TEACHING IN OHIO'S PUBLIC SCHOOLS

A STUDY OF OPINIONS RELATED TO THE NATURE OF SCIENCE AND ITS PURPOSE IN SOCIETY

THE EDUCATION OF HIGH SCHOOL SCIENCE TEACHERS AT MADISON COLLEGE

A STUDY OF CERTAIN FACTORS INVOLVED IN CONSERVATION EDUCATION

COURSE IN PHYSICAL SCIENCE FOR HIGH SCHOOL STUDENTS

COOPERATIVE COMMITTEE REPORT

PROGRAM OF TWENTY-SIXTH ANNUAL CONVENTION OF NARST

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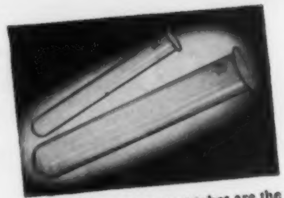

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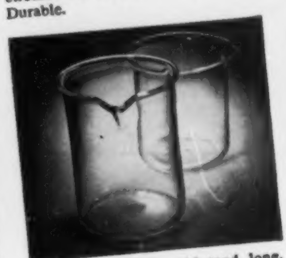

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George Greisen Mallinson

GEORGE GREISEN MALLINSON

Dr. George Greisen Mallinson, Professor of Psychology and Education, Western Michigan College of Education, Kalamazoo, Michigan, was elected twenty-first president of the National Association for Research in Science Teaching at the twenty-sixth annual meeting in Atlantic City, New Jersey. He will preside at the March 29–31, 1954 meeting in Chicago. He succeeds Dr. J. Darrell Barnard of New York University.

Dr. Mallinson was born in Troy, New York, on July 4, 1917. He married Lois Marion Wolfe of Rome, New York. They have two children—a boy, Cyrus James and a girl, Virginia Alice. Dr. Mallinson served in the U. S. Army 1942–45 as Classification Specialist at Camp Upton, New York; Camp Barkley, Texas; Camp Claiborne, Louisiana; and Ft. Sam Houston, Texas.

Dr. Mallinson has A.B. (1937) and M.A. (1941) degrees from the New York State Teachers College, Albany, New York, and a Ph.D. degree in Science Education from the University of Michigan (1947). Teaching experience includes teaching sciences in Whitesboro Central High School, Whitesboro, New York, 1937–41; Head of Science Department, Eden Central High School, Eden, New York, 1941–42; Instructor in Psychology, University of Michigan, 1945–47; Head of Department of Science Education, Iowa State Teachers College, Cedar Falls, Iowa, 1947–48; Professor of Psychology and Education at Western Michigan College of Education, 1948 to date.

Membership in organizations include Sigma Lamba Sigma, Theta Chi Delta, Psi Chi, Kappa Phi Kappa, Phi Delta Kappa, Michigan Academy of Science, Arts and Letters, Michigan Schoolmaster's Club, Michigan Education Association, National Education Association, American Educational Research Association, National Society of College Teachers of Education, American Association for the Advancement of Science, National Council on Elementary Science, National Biology Teachers Association, Central Association of Science and Mathematics Teachers, National Science Teachers Association, and National Association for Research in Science Teaching.

Dr. Mallinson was Burke Aaron Hinsdale Scholar, University of Michigan, 1947. He is a Fellow in the American Association for the Advancement of Science. He has been a member of the Executive Committee of NARST since 1950, serving as Vice-President in 1952–53 and a member of the Junior High School Research Committee since 1950. Since 1949 he has been NARST representative on the Cooperative Committee for the Teaching of Science and Mathematics. He has served as Director of Evaluation for the New York State Regents Examinations in Science for the University of the State of New York Science Survey, 1949 to date. Since 1951 he has been a contributor to the Elementary Science Yearbook of the Department of Elementary School Principals. He has been a member of the Elementary School Science Committee and a member of the Publications Committee of NSTA since 1951.

Dr. Mallinson is co-author with Dr. Francis D. Curtis of *Science in Daily Life* published by Ginn and Company. His master's thesis was entitled "The Individual Laboratory Method Compared with the Lecture-Demonstration Method in Teaching General Biology." His doctoral study was entitled "Materials of Consumer Science for Junior High School."

Contrbutions to various educational publications have been varied and numerous, numbering upward of fifty publications in such journals as *The Science Teacher, School Science and Mathematics, Metropolitan Detroit Science Review, School Activities, Journal of Educational Research,*

Journal of Geography, The American Biology Teacher, School Review, Elementary School Journal, College and University Business, Jobs and Careers, Faculty Contributions, Graduate Division, Western Michigan College of Education, and *Science Education.*

Dr. Mallinson is one of the most active members of the National Association for Research in Science Teaching as measured by articles contributed to magazines, talks before various science groups, or by membership on committees. Many of his friends are amazed that he finds the time to do so much and to do it so well. His many writings are acclaimed for their excellence. As a comparatively young man, his accomplishments to date augur well for future dynamic leadership in science education.

E. Laurence Palmer of Ithaca Wins Nash Conservation Award

E. LAURENCE PALMER, Professor Emeritus of Cornell University, Ithaca, New York, (right) was presented with Nash Conservation Award by George W. Mason, president and chairman of the board of the Nash-Kelvinator Corp., at the first annual Awards dinner in the Hotel Statler, Washington, D. C. Palmer, who is an educator associated with the National Wildlife Federation, also received a cash grant of $500. He was one of twenty national award winners and was selected from among 729 nominees. He was honored for his leadership as one of the nation's leaders in the field of conservation education.

Dr. E. Laurence Palmer was selected as

one of the ten professional conservationists who had made an outstanding contribution to his country's conservation of natural resources, it was announced by the judges of the first annual Nash Conservation Awards. Mr. Palmer is an educator associated with the National Wildlife Federation, at Ithaca, New York.

Mr. Palmer received an all-expense trip to Washington, D. C., where he was honored at a dinner held at the Hotel Statler on January 7.

George W. Mason, president and chairman of the board of Nash-Kelvinator made the formal presentation of the awards. In a statement explaining the significance of the program, he said, "The automobile industry has a stake in conservation because so much of the enjoyment of the outdoors depends upon the automobile. We hope this program will impress upon the public the wide scope and scientific nature of modern conservation."

"Today's professional conservationists are mostly highly trained technicians," he said, "and these awards are going to men whose work has heretofore been little known or understood by the general public. We also want to give well-deserved recognition to amateur conservationists, without whose work the professional would be greatly handicapped."

Dr. Palmer is recognized for his long service and achievements in the conservation field by his professional associates, but his name is little-known by the general public. With the exception of a period of service in the U. S. Navy in World War I, Dr. Palmer has taught for 43 years. For 33 of those years, he was a professor of rural education and conservation at Cornell University.

As editor of the Cornell Rural School Leaflet, a quarterly that provided nature-study guidance and material for teachers in New York State, and through his tutelage of more than 4,000 students at the university, he has exerted a profound and lasting influence upon the course of conservation education.

He has developed pioneering courses in field natural history, outdoor living, and nature writing, and the teaching of conservation.

In addition to his achievements as an educator, Dr. Palmer has an amazing record as a writer on the subject of conservation. He is the author of more than 500 articles and several books on the subject. His book entitled, "Field Book of Natural History" is perhaps his most widely-known work.

Palmer also served as director of education for the American Nature Association and has written regularly scheduled articles for *Nature Magazine*.

Three years ago he became director of conservation for the National Wildlife Federation and has served this organization in a full-time capacity since his retirement from Cornell University in 1952. His work for the Federation includes preparation of teacher-student guides and reference materials which are distributed free to schools of the nation; authorship of regular feature stories on nature subjects appearing in some 1200 weekly newspapers; counseling at teachers conventions; preliminary screening of grant-in-aid applications from state affiliates of the National Federation; screening and administration of Ding Darling Graduate Fellowships; plus numerous odd jobs utilizing his vast nature lore, his teaching ingenuity and his writing skill.

In July of 1953, Dr. Palmer supervised the conservation program and exhibits at the National Boy Scout Jamboree at Santa Ana, California, where 28,000 scouts were introduced to one or several fields of natural resource management.

The Committee on Awards consisted of Michael Hudoba, Washington correspondent of Sports Afield magazine; Johnny Mock, Conservation editor, Pittsburgh Press; Ed Dodd, creator of the "Mark

Trail" cartoon strip; Alastair MacBain, Chief of the Information Bureau, U. S. Fish and Wildlife Service; and Pieter W. Fosburgh, editor of the New York State Conservationist.

Science Education wishes to add its congratulations to Dr. Palmer on winning this outstanding honor. It is a distinction most deserving in every way. Dr. Palmer is a charter and life member of the National Association for Research in Science Teaching.

A COOPERATIVE APPROACH TOWARD EVALUATION OF SCIENCE IN GENERAL EDUCATION AT THE COLLEGE LEVEL *

W. C. VANDEVENTER

Western Michigan College of Education, Kalamazoo, Michigan

THE Cooperative Study of Evaluation in General Education of the American Council on Education was set up in December 1949 under the chairmanship of Dr. Paul L. Dressel of Michigan State College. Six major curricular areas were included in the study. These were: communication, critical thinking, humanities, science, social science and the composite area embracing attitudes, values, and personal adjustment.

The basic philosophy of the study involved an attempt to tie together the rather unsystematic growth of the general education programs which have been put into effect by various colleges and universities during the past quarter century. It was felt that this could be accomplished through a cooperative consideration of common problems and goals, particularly in terms of an attempt to evaluate the attainment of these goals. From this standpoint some aspects of the study were highly successful. A broad common ground among cooperating institutions in relation to the total general education movement was discovered, and a series of tests were devised to attempt to measure this common attainment. The work also proved valuable in orienting not only the participants themselves, but also their colleagues, in the matter of course planning and teaching procedures looking toward the realization of some of the goals of general education. The broader aspects of the study have been described by Mayhew (1952) and Dressel and Mayhew (1953).† The present paper is primarily concerned with the activities of the committee which worked in the science area.

Most such studies have concentrated first on the problem of selection of subject matter for courses, at the same time giving lip-service to the frequently stated goals of science in general education, and leaving until later the questions of method of presentation and evaluation. In this study a careful re-examination and delineation of goals was first undertaken, followed immediately by a consideration of the problem of how best to evaluate student achievement of these goals. From the foundation thus established the twin problems of what subject matter to use in order to reach these goals and how to present it effectively naturally followed.

Of the nineteen college and universities which participated in the study, sixteen were represented on the Science Committee.‡

* Paper presented at Twenty-Sixth Annual Meeting of The National Association for Research in Science Teaching, Atlantic City, New Jersey, February 17, 1953.

† Mayhew, Lewis B. "The Cooperative Study of Evaluation in General Education", *School and Society,* Vol. 75, No. 1940, February 23, 1952, and Dressel, Paul L. and Mayhew Lewis B. "The Cooperative Study of Evaluation in General Education," *The Educational Record,* January, 1953.

‡ The schools represented were: Antioch College, Boston University, Colgate University, Colorado State College of Education, Drake University, Kansas State College, Kansas State Teachers College, Michigan State College, Musk-

The work of this committee was carried on through three summer workshops and four short winter and spring meetings. In addition to these, three members of the group under the chairmanship of the writer were designated to act as editors of the preliminary test forms during a two-week period in the spring of 1951.

The committee began its work by exploring a wide range of goals of science learning in general education. It was recognized that the goal of knowledge of subject matter was probably being evaluated already, if not adequately, at least acceptably, through the use of instruments and techniques now available. It was decided, therefore, that the committee could most profitably deal with goals which lay above and beyond knowledge of subject matter. Three such goals were: (1) Ability to apply science knowledge, skills and principles to new problems and situations, (2) Ability to read and evaluate news articles and other popular writing on scientific developments, and (3) Ability to understand the point of view with which a scientist approaches his problems and the kinds of things that he does.

Since the students who take general education college science courses do not as a rule bring to these courses a wide range of technical knowledge or terminology, and since most of them do not go into advanced work in scientific fields, their continued contact with science beyond their general education experience comes largely as a result of (1) meeting science problems in situations of daily living, and (2) reading popular accounts of science research and developments in newspapers and magazines. It appeared that the devising of testing instruments which would measure the ability of students to meet and solve problems of science in situations of daily living would be extremely difficult, and that furthermore, the testing process must necessarily be carried out within the limits of classroom time. Therefore, the committee decided to concentrate on evaluation of the ability to read, interpret and evaluate accounts of scientific developments written at the popular level. It was felt also that the ability to apply science knowledge to new situations, and the ability to understand the point of view of a scientist and the kinds of things that he does could be evaluated in terms of the student's reaction to such popular science materials.

The members of the committee therefore collected suitable excerpts from popular science writings and used these as composite stems for the preparation of blocks of test items aimed at measuring the three chosen goals.

It seemed desirable in implementing these goals that the test items should fit into five categories: (1) Ability to recognize and state problems, (2) Ability to select, analyze and evaluate information in relation to a problem, (3) Ability to recognize, state and test hypotheses, (4) Ability to recognize, evaluate and formulate conclusions and generalizations, and (5) Ability to recognize and formulate attitudes and take action after critical consideration.

These categories were expanded into an instrument to aid in formulating and balancing the test items. This was called the "Guide for Construction of Evaluation Items". This instrument is included here in order to show the direction of the committee's thinking and the method of operation which they employed.

Guide For Construction of Evaluation Items [1]

1. *Problems*—ask a question which requires the student:

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ingum College, Oklahoma A. and M. College, Pennsylvania College for Women, Stephens College, University of Minnesota, University of Florida, Western Washington College of Education and Wright Junior College. In addition to the representatives of these institutions, specialists from Brooklyn College, Wayne University and Educational Testing Service also participated in the work of the committee.

[1] Taken from the report of the third summer workshop of the Science Committee of the Cooperative Study for the Evaluation of General Education of the American Council on Education. East Lansing, Michigan, August, 1952.

a. to identify the problem to which the statement gives the answer and to recognize the central problem to which a number of statements are addressed.

b. to indicate, with reasons, whether or not a given problem is stated specifically enough to begin an investigation of it to obtain an answer.

c. to indicate whether certain non-scientific factors, such as value judgments, matters of faith, are contained in the problem, thereby making a scientific solution impossible.

2. *Information*—(data, laws and principles)—ask a question which requires the student:

a. to recognize when the information he possesses is inadequate for a given problem.

b. to indicate kinds of sources of information appropriate for a given problem.

c. to evaluate the authenticity of given sources of information in relation to a given problem.

d. to indicate his ability to apply information he possesses or has gathered to the solution of a given problem.

3. *Hypotheses*—ask a question which requires the student:

a. to formulate or recognize hypotheses based on given data or situations.

b. to identify reasons (including assumptions) serving to support a given hypothesis.

c. to identify the evidence necessary to judge the truth of a given deduction from an hypothesis.

d. to formulate an experiment which will test the truth of a given hypothesis.

4. *Conclusions*—ask a question which requires the student:

a. to recognize the difference between statements or interpretations based on scientific evidence and those which contain opinion.

b. to recognize the generalization(s) involved in an interpretation or conclusion.

c. to indicate the adequacy or inadequacy with which given data support given interpretations or conclusions.

d. to recognize in a paragraph or statement proper or improper use of such reasoning as deduction, induction, citing authority, analogy.

e. to recognize in a line of reasoning whether an observation plays the role of a premise or verifies the conclusion.

f. to differentiate fact and assumption in a paragraph or statement.

g. to detect the unstated assumptions involved in a conclusion partially based on evidence.

h. to recognize when evidence used in context is adequate for drawing a conclusion.

5. *Attitudes*—ask a question which requires the student:

a. to recognize in a paragraph or statement proper or improper use of such concepts as causality, teleology, parsimony, consistency, tentative nature of truth, operationalism.

b. to assess a situation and recognize appropriate action in harmony with the nature of science and society.

The blocks of written material upon which test items were based were chosen from both physical and biological areas. A strong effort was made in the preparation of the final forms of the basic tests to include a balance of material from both areas. In these tests the committee attempted to keep the level of vocabulary and technical knowledge sufficiently general that teachers in either general physical science courses, general biological science courses or combination courses could use them. It was felt that this was possible without damaging the effectiveness of the tests, since the goals that they were designed to measure, while necessarily approachable only through the medium of subject matter, nevertheless lay above and beyond subject matter in the realm of scientific thinking and attitude common to all sciences.

In addition to these basic or general tests, other tests of a more specific nature, aiming at measurement of student attainment of the same goals, were prepared in both the physical and biological areas. These differed from the general tests mainly in giving greater emphasis to technical vocabulary and detailed scientific knowledge.

The following two blocks of items, one from the physical science area and one from the biological science area, are included here in order to illustrate the carrying out of the committee's procedures and goals.

Block I[2]

Read the following selection carefully. It is adapted from *Time.*

The year 1950 is the hundredth anniversary of the landing of English sparrows in the United States. They are really

[2] From "A Test of Science Reasoning and Understanding, Natural Sciences, Form C". Cooperative Study of Evaluation in General Education of the American Council on Education. 1952.

neither sparrows nor English. They are weaver finches, originally from Africa, that have attached themselves, like the dog, bedbug, and rat, to the fortunes of man. They colonized Europe long ago, swarming in its cities paved with nutritious refuse. In 1850, they reached Brooklyn.

Brooklyn in those days was plagued with insects. The native birds did not like city life. As U. S. cities expanded, the birds retired to rural refuges, leaving the shade trees and flower gardens defenseless against insect pests. Finally the Brooklyn Institute of Arts and Sciences sent to England for an urban bird—the English sparrow.

The birds found the city a sparrow's paradise. The streets were strewn with the refuse of the horse and buggy age, and under each bright street light there was a collection of dead insects. The sparrows soon overflowed Brooklyn. Riding in empty grain cars along new-built railways, they pioneered the West. By 1886, they had occupied all of the U. S.

Soon there were cries of anguish from bird lovers. The violent, aggressive English sparrows were too successful. Wherever the sparrows came, blue birds and wrens got out. Audubon Society members reported native birds being pursued, insulted and pecked by sparrows. Said Biologist Ned Dearborn of the U. S. Biological Survey, "The English sparrow among birds, like the rat among mammals, is cunning, destructive, and filthy."

But by the 1920's the sparrow hosts were declining. Their downfall was not the Audubon Society, but the automobile. As horses grew scarcer, sparrows grew scarcer, too. Now they survive in cities mostly on the leavings of pigeons.

In some smaller U. S. cities sparrows are still plentiful. There they have solved their food problem by a kind of inverse commuting. True to their urban traditions, they build their nests in town. In the mornings they fly out to the country to forage in the grainfields and barnyards. Then they come back, full fed, for the brawling social life in town.

Directions: For each of the following items select the best answer and mark the corresponding space on the answer sheet to the right of the item number.

1. The English sparrows were introduced into Brooklyn in an attempt to solve a problem. This problem was how to
   1. dispose of street refuse.
   2. lure the native birds back into the city.
   3. enable birds to live with human beings.
   4. get some kind of bird life re-established in the city for aesthetic reasons.
   5. restore something approximating a balance of nature.
2. The introduction of the English sparrow was most similar to
   1. a chance occurrence.
   2. an uncontrolled experiment.
   3. a controlled experiment.
   4. a study made under natural conditions.
   5. a "shot in the dark".
3. The situation described in the fourth paragraph which arose as a result of the migration of the English sparrows over the United States, was due to
   1. a decrease in the total number of birds.
   2. an increase in the number of native birds.
   3. the inability of the native birds to live in the towns.
   4. the inability of the native birds to compete with the English sparrows.
   5. the inability of the English sparrows to compete with the native birds outside of the towns.
4. The situation referred to in the preceding item resulted in the
   1. formation of some new natural relationships.
   2. improvement of some old natural relationships.
   3. reconstruction of original natural relationships.
   4. abolition of all natural relationships.
   5. deterioration of all natural relationships.
5. With the coming of the automobile, the number of English sparrows has decreased because
   1. the English sparrows now no longer compete with the native birds.
   2. the native birds have increased their ability to compete with the English sparrows.
   3. a new factor has been introduced leading to the destruction of the old relationship.
   4. a factor in the old relationship has been reduced in importance, leading to the development of a new relationship.
   5. the English sparrow is not a native bird.
6. The new "commuting habits" of some English sparrows indicate
   1. an adjustment of the species in connection with the attainment of a new relationship.

2. an attempt by the English sparrow to maintain the old relationship.
3. that the species is on the way to becoming extinct in America.
4. that the species is again increasing to its former numbers.
5. that the English sparrow is becoming a country bird rather than a city bird.

7. The statement by Dearborn, "The English sparrow among birds, like the rat among mammals, is cunning, destructive and filthy", is
   1. an hypothesis.
   2. a guess.
   3. a verified conclusion.
   4. an opinion.
   5. an established fact.

8. On the basis of the article, the statement that the English sparrow is a bird which is associated with human dwellings, towns, and cities would be
   1. an hypotheses.
   2. an assumption.
   3. a conclusion.
   4. a theory.
   5. an unwarranted assertion.

9. On the basis of the article, a statement that the English sparrow may be expected to become a permanent component of the bird life of temperate North America, would be
   1. a reasonable hypothesis.
   2. an assumption.
   3. an unwarranted assertion.
   4. a proved fact.
   5. an unwarranted conclusion.

10. The most effective method of testing the validity of the statement given in item #9 would be to take a census of
    1. all English sparrows in ten American cities of different sizes.
    2. all native birds in ten American cities of different sizes.
    3. all birds, including English sparrows in ten American cities of different sizes.
    4. all birds, including English sparrows in ten American cities of different sizes, and in a ten-mile zone around each city.
    5. all birds, including English sparrows, in ten American cities of different sizes, and in a ten-mile zone around each city, at ten-year intervals.

11. In evaluating the factors which will determine what part various species will play in the total bird population of the United States 100 years from now, a scientist expects that
    1. the native species will eventually triumph.
    2. man will determine which species survive and which do not.
    3. the influence of the Audubon Society and other bird-lovers will weigh strongly in favor of the native species.
    4. those species will survive and increase which are best able to do so in competition with others in the environment which man has modified.
    5. in this length of time there will be new species that are better adapted to man-modified conditions which will evolve and replace those which are now here.

12. Between 1850 and 1950 which one of the following was the most important in the solution of the problem resulting from the introduction of the English sparrow?
    1. Increase and decrease in the number of English sparrows.
    2. Decrease in the number of other birds in towns.
    3. Relationship of other birds to English sparrows.
    4. Change in the food habits of the English sparrows.
    5. Relationships of native birds, English sparrows, horses, and human beings to one another.

Block II [3]

Read the following selection carefully. It is adapted from *Time*.

The northwestern tip of Quebec, just south of Baffin Island, is flat, sodden tundra sprinkled thickly with little lakes. Most of them are irregularly shaped. But Prospector Fred W. Chubb noticed, while poring over an aerial photograph, that one lake was almost round and surrounded by a wall of rock. This week Dr. V. B. Meen, field geologist, Ontario Department of Mines, returned from a quick air visit to the lake and reported that it was almost certainly a meteorite crater (there was no lava or other sign of volcanic activity), and the biggest yet discovered. The lake in the crater is two and one-half miles across, compared with Arizona's famed meteorite crater, which is four-fifths of a mile across. Its level is about 80 feet above that of other small lakes in the vicinity, and around it is a ring of shattered granite that rises 550 feet above the tundra. The rim is lowest on the northwest side, which suggests that the meteorite came from that direction and hit the ground obliquely.

[3] Ibid.

Dr. Meen found no meteoric iron, only a reddish rock that might prove to be the peculiar stony material of which some meteorites are made. But there was plenty of other evidence that some enormous body had buried itself in the earth: shattered blocks of stone from football to freight-car size, and concentric circles in the granite around the crater, like ripples stirred up by a pebble dropped into still water.

Dr. Meen estimated that the meteorite must have fallen at least 3,000 years ago, since there are no Indian or Eskimo legends about it. He named it Chubb Crater after the sharp-eyed prospector, and promised that a full-dress expedition would report on it within a year.

Directions: For each of the items *38–46* select the best answer, then mark the corresponding space on the answer sheet.

38. The basic problem which faces a scientist in the case of this lake is the
   1. shape of the lake.
   2. size of the lake.
   3. high elevation on the lake.
   4. origin of the lake.
   5. depth of the lake.
39. This problem was suggested by the
   1. shape of the lake.
   2. size of the lake.
   3. high elevation of the lake.
   4. origin of the lake.
   5. depth of the lake.
40. Which one of the following statements is least related to the basic problem?
   1. "The northwestern tip of Quebec . . . is flat, sodden tundra, sprinkled thickly with little lakes."
   2. ". . . One lake was almost round, and surrounded by a wall of rock."
   3. "There was no lava or other sign of volcanic activity."
   4. "Its level is about 80 feet above that of other small lakes in the vicinity, and around it is a ring of shattered granite that rises 550 feet above the tundra."
   5. (There were) "concentric circles in the granite around the crater, like ripples stirred up by a pebble dropped into still water."
41. Which one of the following statements would represent the attitude of a scientist?
   1. He would not say that the lake was of meteoric origin unless he had seen the meteor fall.
   2. He would say that the lake was of meteoric origin if he had any evidence that pointed in that direction.
   3. He would say that the lake was probably of meteoric origin if evidence from many different sources pointed in that direction.
   4. He would state that the lake was of meteoric origin and then he would attempt to prove it.
   5. The economic conditions of the region would influence his interest in the origin of the lake.
42. The statement "It was almost certainly a meteorite crater is
   1. a scientific fact.
   2. evidence in support of a scientific fact.
   3. an unfounded assumption.
   4. a reasonable hypothesis.
   5. a chance guess.
43. Which one of the following lines of study would probably furnish the most conclusive means of testing the idea of meteoric origin of the lake?
   1. Compare the lake with other lakes in the immediate vicinity.
   2. Accurately survey the lake and the territory immediately around it.
   3. Look for other lakes like this lake in other parts of Quebec and Baffin Island.
   4. Compare the lake in detail with known meteoric craters.
   5. Determine the structure and composition of the rock found in the vicinity of the lake.
44. Which one of the following statements is the best example of an hypothesis?
   1. "Dr. Meen found no meteoric iron, only a reddish rock that might prove to be the peculiar stony material of which some meteorites are made."
   2. "The rim is the lowest on the northwest side, which suggests that the meteorite came from that direction and hit the ground obliquely."
   3. "Prospector Fred W. Chubb noticed . . . that one lake was almost round and surrounded by a wall of rock."
   4. "The lake in the crater is two and one-half miles across, compared with Arizona's famed meteorite crater, which is four-fifths of a mile across".
   5. Dr. Meen "promised that a full-dress expedition would report on it within a year".
45. The face of the moon shows many craters similar to the Chubb and Arizona craters, most of which are larger than either of these. If these craters, on the moon were formed by meteorites, why are there fewer of them on the earth?
   1. The moon has no atmosphere, and therefore there is no erosion working on the moon to destroy the craters.
   2. More meteorites strike the moon than the earth, because the moon is located out in space where the meteorites can reach it more easily.

3. The moon is smaller than the earth and therefore the moon is more susceptible to being buffeted by meteorites.
4. The natural laws that operate on the earth do not operate on the moon.
5. The moon is older than the earth, and therefore has had more time for meteorites to strike it.

46. According to some theories of the origin of the solar system, the earth and moon and other planets and their moons were formed at one stage by a process in which the larger fragments picked up the smaller ones as they all traveled around the sun. Accordingly to this, the present occurrence of meteorites on earth is merely a vestige of the much greater bombardment which took place in earlier days. Following out this idea
    1. the moon is now being bombarded as the earth was in its early history.
    2. the moon's surface has retained the effects of early bombardment.
    3. the role played by meteorites in the formation of the moon is not the same as in the formation of the earth.
    4. the chances of a large meteorite striking the moon are considerably greater than of one striking the earth.
    5. large meteorites strike the earth now only in remote, uninhabited places.

One of the most important accomplishments of the committee had to do with a realization of the importance of selecting subject matter and utilizing teaching methods which are in harmony with the specific goals which are set forth. All too frequently the goals of general education have been stated in such broad terms that very little thought is given to them in connection with actual course work. Too often the actual practice of general education in the classroom has consisted simply of a presentation of more or less integrated subject matter spread thin. Since most teachers have come up through a relatively rigid subject matter training, they have convinced themselves that by exposing the student to a wide variety of subject matter, and then testing for a knowledge of it, they are attaining the understandings and attitudes which have been widely publicized as the goals of general education.

The members of the committee, by working together over an extended period, and comparing ideas and methods which they had found to be successful in their own institutions, were able to improve their own understanding of what general education in science is, and to evaluate subject-matter selections and techniques comparatively. Furthermore, by constantly thinking of these things in terms of the dual problem of setting up valid goals and evaluating student achievement in relation to them, the participants were able to sharpen their discernment of weaknesses in their own practices. The following instrument was devised for teachers to use in evaluating and revising their courses.

Is Your Course Accomplishing What You Think It Is?[4]

Ask yourself the following questions concerning it:

1. What end results do you expect in terms of student understanding and/or behavior?
    a. Are the stated goals of the course interpretable in terms of these expected end results? (If they are not, then they should be discarded or revised accordingly.)
    b. Is each unit of the course interpretable in terms of these expected end-results? (If it is not, then it should be discarded or revised accordingly.)
    c. Is each experience within each unit interpretable in terms of these expected end-results? (If not, then the experience should be discarded or revised accordingly.)
2. What materials do you expect to use in bringing about the expected end-results? (E.g., textbooks, reference books, original papers, research articles, science-in-the-news, laboratory apparatus and materials, field observations, audio-visual materials, etc.)
    a. How, where and to what extent do you plan to use each type of material that you include?
    b. Is the use of each item of material interpretable in terms of the expected end-results? (If it is not, then its use should be discarded or revised accordingly.)
    1. In consideration of methods of presentation of this material, go to (4) below.
    2. In consideration of the use of this material for evaluation of student achievement, go to (5) below.
    3. In consideration of the use of this material in the instructional process, continue with (3).

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[4] Taken from the Report of the First Summer Workshop of the Science Committee of the Cooperative Study for the Evaluation of General Education of the American Council on Education. East Lansing, Michigan, August 1950.

3. What teachable problems in relation to the expected end-results are included in the materials selected for instruction? (If the problem situations to be used in teaching are not adequately presented in the selected materials, then the materials should be supplemented, revised or discarded.)
   a. Do the problem-situations selected for study fit into the planned units of the course? (If not, then the units should be revised or new problem situations should be substituted.)
   b. Are the problem-situations capable of being presented specifically, unambiguously and in terms with which science can deal. (If not, then they should be (1) discarded or, (2) presented in such fashion that the relation of science to them and its limitations in dealing with them are clearly apparent.)
4. What methods do you plan to use in bringing about the expected end-results? (E.g., lectures, laboratory exercises, experiments, field trips, demonstrations, audiovisual presentations, discussions, projects, required readings, etc.)
   a. How, where and to what extent do you expect to use each method that you include?
   b. Is the use of each method in each particular situation interpretable in terms of the expected end-results? (If it is not, then its use should be discarded or revised accordingly.)
5. How do you plan to evaluate student progress and/or achievement in terms of the expected end-results?
   a. Isolate concise problem-situations which are related to the problem areas or units of the course.
   b. Are these problem-situations interpretable in terms of the expected end-results? (If not, then they should be discarded.)
   c. Ask yourself what problem statements and/or questions derivable from these problem-situations can be asked of the student in terms of the expected end-results.
   d. Ask yourself if these problem statements and/or questions are stated specifically, unambiguously and in terms with which science can deal.
   e. Determine what particular types of evaluation items (essay, objective of various kinds, etc.) you can best use for deriving student responses in connection with your problem statements and/or questions.
   f. Ask yourself whether the expected student responses are interpretable in terms of the expected end-results. (If they are not then the evaluation items should be modified or discarded.)

The committee recognized that the goals which it selected for evaluation were by no means inclusive of all of the goals of general education. Knowledge of subject matter is certainly itself a valid goal. It was felt, however, that one of the important ways in which general education differs from special education is that it tends to treat subject-matter as a means for reaching the understandings which make people better citizens of our modern science-oriented world, rather than as an end in itself. The goals upon which the committee concentrated its efforts represented a definitely limited objective. They were those toward which it was believed progress could be made in terms of measurement, and which would reach beyond subject matter toward the broader aspects of general education.

APPLYING BIOLOGICAL PRINCIPLES TO PHYSICAL SCIENCES *

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How can instruction in the biological sciences be applied to the physical sciences? The purpose of this study is to determine the applications of several biological principles to a generalization, concept, principle or problem in the physical sciences, astronomy, chemistry, geology, or physics. Several studies that suggest the integration of the natural sciences in teaching science for general education recently appeared in professional journals. However, no specific recommendations were made as to which topics or principles of a given science may be integrated with topics or principles of a different science.

* Paper presented at Twenty-Sixth Annual Meeting of The National Association for Research in Science Teaching and at the American Educational Research Association held in Atlantic City, New Jersey, February 16 and 17, 1953.

Method

A sample of five principles † of biology for general education was listed in a questionnaire. Fifty questionnaires were returned by members of the National Association for Research in Science Teaching representing all of the areas in the natural sciences. The respondees are teaching the sciences in various sections throughout the United States. They were asked to list those generalizations or principles in the physical sciences which may be more familiar to students of biology and/or giving the students useful concepts or items of knowledge from the physical sciences in order that they will understand the biological principles. This was done individually for each of the five biological principles that appeared in the questionnaire.

Findings

The first biological principle listed in the questionnaire was: *Practically All the Food in the World in Addition to other Substances is Produced Directly or Indirectly Through the Process of Photosynthesis where Carbon Dioxide and Water, in the Presence of Sunlight and Chlorophyl-Bearing Plants are Converted into Intermediate Substances that Ultimately Form Starch and Liberate Oxygen.* The following concepts or topics in the physical sciences were listed as applications from the first principle of biology stated above. The number which precedes these physical science statements represents the frequency with which they were mentioned as applications of the biological principle to the physical sciences.

28 Energy (potential, kinetic, radiant, transformation)
19 Factors governing speed of chemical reactions
12 Conservation of matter and energy
12 Synthesis of compounds
7 Atomic—molecular theory
7 Oxidation-reduction
4 Electromagnetic-energy spectrum
3 Physical state of matter
3 Entropy
1 Quantum Theory
1 Osmosis
1 Dehydration
1 Volcanism—supplying carbon dioxide

The second biological principle listed in the questionnaire was: *Fermentation and Putrefaction Are Usually Caused by Living Micro-Organisms.* The following topics in the physical sciences were listed as applications from the second biological principle stated above. The frequency with which they were mentioned appears with the topic.

15 Chemical change
12 Oxidation-reduction
10 Catalysis
5 Decomposition
4 Energy transfer
4 Production of industrial alcohol

In one or two instances, the following topics were mentioned: organic reaction, solubility, diffusion, hydrogen ion concentration, and anti-biotics.

The third biological principle listed in the questionnaire was: *The Earth's Surface and Its Surrounding Atmosphere Are Changing Constantly and Demand that Organisms Migrate, Hibernate, Aestivate, Build Artificial Shelters or Otherwise Become Adapted to These Changes.* The following concepts in the physical sciences were listed as applications from the third biological principle stated above. The frequency with which they were mentioned appears with the topic.

23. The earth's surface is changed by the interaction of non-living environmental factors and living organisms (diastrophism, erosion, orogeny, isostasy, surface of earth in relation to position of natural rays of sun).
5. Problem of seasonal and climatic changes
3. Physical and chemical forces at work on earth affect man

Other topics mentioned were composition of the atmosphere and the earth's crust, meteorology and air conditioning, characteristics of physical and chemical change, conservation, Le Chatelier's Principle.

The fourth biological principle listed in the questionnaire was: *Osmosis, the Diffusion of Molecules of Water Through a Dif-*

† Washton, Nathan S. "A Syllabus in Biology for General Education" SCIENCE EDUCATION 35: 84–92 March 1951 and 36:227–237 October 1952.

ferential Membrane from the Region of Higher Concentration to a Region of Lower Concentration, with a Stoppage of the Flow of the Molecules of the Solute, Is a Basic Process in Plant and Animal Physiology. The number which precedes these physical science concepts represents the frequency with which they were mentioned as applications of the biological principle to the physical sciences.

24. Kinetic theory (kinetic molecular energy)
13. Mechanics of liquids
11. Nature of solution (ionization, laws of solubility)
11. Diffusion of substance

The fifth biological principle that appeared in the questionnaire was: *The Carbon Cycle Occurs in Nature as a Result of the Decomposition of Carbon Compounds of Organisms which Replenishes the Carbon Supply in the Atmosphere in the Form of Carbon Dioxide.* The following physical science topics were listed as applications:

16. Matter and energy (transformation and conservation)
14. Oxidation-reduction
10. Chemical change
4. Carbon cycle and sun (atomic energy)
4. Ice age theory

Recommendations

Since the findings in this study indicate that several biological principles may be applied to concepts or topics pertaining to energy, chemical change, catalysis, molecular theory, diastrophism, erosion, orogeny, isostasy, and mechanics of liquids, it is suggested that experimental syllabi be developed for science courses for general education. These syllabi could be constructed by individual science departments such as biology in which applications to the physical sciences are made. A physical science, chemistry, or physics department could likewise design a syllabus in the physical sciences which emphasizes applications to the biological sciences. It is also feasible to develop an integrated science course for general education in which applications are made among the several sciences.

It is recommended that studies be made to determine the possible application of the natural sciences to other areas of human endeavor: government, economics, industry, psychology and sociology. Our contemporary civilization has already experienced the impact of modern science via atomic energy. The teaching of science and the effects of scientific research and technology are no longer the concern of the scientist alone. Today, science demands that man adjust himself to a changing environment. The future of science and man in society may imply that this adjustment is essential if man is to survive. How can all of our resources in government, industry, agriculture, both people and materiel, be pooled to enable our citizens to make a more effective adjustment in our democratic way of life? Perhaps if a series of studies are undertaken to show where there are vital applications from one area of knowledge or problems of living to other fields of endeavor, we may have a basis for building a more secure and better adjusted society.

Although the approach of this study was primarily done through a sampling of biological principles, it is not recommended that pupils be asked to merely memorize them in order to obtain a general education. Students should experience a vast array of vital, stimulating, learning activities that should enable them to understand and apply these scientific principles for more intelligent and effective living. Therefore, many learning experiences such as experiments, visits, consultations, demonstrations, use of audio-visual aids, reading materials, construction work, and discussions should be integrated to help students arrive at basic generalizations, principles, or ideas and to help them solve problems.

Additional studies are needed to determine the criteria of science courses for general education, applications from one science to another, applications of the natural sciences to the social sciences, evaluation of science courses for general education, the measurement of attitudes and behavior de-

veloped or modified as a result of science instruction. These areas require a series of investigations if we are to provide young people with a sound, functional understanding of science which is required for better living in our society.

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TEST ITEMS AND CURRICULUM BACKGROUND AS FACTORS WHICH INFLUENCE RESULTS IN EVALUATING LEARNING IN HIGH SCHOOL GENERAL SCIENCE * †

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Introduction

THIS study is presented as an illustration of how statistical findings, even though significant, may sometimes lead to overgeneralized conclusions. This article proposes to show the necessity for careful interpretation and analysis. In the illustration discussed here, a comparison was made of the achievement in general science of 178 matched pairs of eighth term academic high school pupils and vocational high school pupils.

On the basis of the gross results, the academic pupils showed a statistically significant superiority. However, when the curriculum background of the participating pupils was analyzed, it was found that the pupils could be separated into two distinct curriculum groups. When the test items of the examination which was used was analyzed according to its subject contents, it was found that one of the two sub-groups was in a more favored position, by virtue

* Paper presented at Twenty-Sixth Annual Meeting of The National Association for Research in Science Teaching, Atlantic City, New Jersey, February 17, 1953.

† This study was part of a survey entitled "Measuring the Effectiveness of Instruction in Vocational Education," conducted by J. Wayne Wrightstone. Cooperating in the study reported here were R. Egbert, G. Forlano, and J. Justman of the Bureau of Educational Research.

of its curriculum experiences, to achieve better results. Details of how the study was conducted and specific data of the achievements of the groups follow.

A Comparison of the Matched Pairs As a Whole

In attempting to compare the achievement in science learning of academic and vocational high school pupils, a sampling of 178 matched pairs of eighth term pupils was selected. These had been matched according to IQ, terms in school, and age. These pupils were given the Cooperative General Science Test, Revised Series, Form Q. The academic high school pupils scored significantly higher than the vocational high school pupils, as is indicated in Table I below.

TABLE I

A COMPARISON OF THE ACADEMIC AND VOCATIONAL PUPIL'S MEAN SCORES ON THE COOPERATIVE GENERAL SCIENCE TEST AND THE SIGNIFICANCE OF THE DIFFERENCE

School	No. of Pupils	Raw Score
Academic	178	42.47
Vocational	178	36.48

The difference favored the academic group. One would be lead to conclude that there was little or no doubt about this, since the difference was statistically significant. However, the difference in the academic and vocational curriculum suggested the hypothesis that one group, because of its school experiences, might have been in a better position to answer the items on the Cooperative General Science Test. Accordingly, an analysis of the science curriculum background of the 178 matched pairs of pupils was made.

As a result, it was found that 71 of the academic pupils had been exposed to a curriculum of general science and 73 had studied applied science. Since all of the vocational pupils had studied applied science, it was possible to form two sub-groups of academic-vocational matched pairs. One group, to be referred to as A, was composed of 71 matched pairs of pupils who had had different science backgrounds (general-applied). The other group, to be referred to as B, was composed of 73 matched pairs of pupils who had had a similar science background (applied-applied).

A Comparison of the Sub-groups with Different Curricula

The next step was to compare the Cooperative Science Test scores of the academic and vocational pupils in Group A, and then those of Group B in order to learn whether a difference in science curriculum background had any effect on their respective achievements. In Table II, which follows, the difference in mean scores and the statistical significance of the difference is given for Group A and for Group B.

An analysis of Table II indicates that in Group A, where the pupils had studied under different science curricula, the academic pupils made a statistically significant gain of 7.18 points on the raw scores of the

TABLE II

A COMPARISON OF THE MEAN SCORES OF THE ACADEMIC AND VOCATIONAL SCHOOL PUPILS IN GROUP A AND GROUP B AND THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN SCORES

	Group A 71 Matched Pairs of Pupils		Group B 73 Matched Pairs of Pupils	
	Academic	Vocational	Academic	Vocational
Science Curriculum	General	Applied	Applied	Applied
Mean Score	45.31	38.13	39.94	36.38
S.D.	16.85	16.55	11.15	15.75
$S.E._M$	2.00	1.96	1.30	1.84
D	(ac-voc)	7.18	(ac-voc)	3.56
$S.E._D$		2.80		2.25
t		2.564		1.582
P	**	.02–.01		.20–.10

test over the vocational school pupils. This was shown by the t ratio of 2.564. In terms of probability or P, there was only 1 chance in a 100 that the difference found was due to chance factors rather than true ones.

In Group B, where both academic and vocational pupils had studied applied science, the difference of 3.56 points in the test raw scores in favor of the academic pupils was not statistically significant. The t ratio of 1.582 indicated that the probability, or P, was that there were 10 to 20 chances out of 100 that the difference was due to chance factors.

Previous to the partialing out of Groups A and B from the whole body of 178 matched academic-vocational pairs, it was shown that the achievement, as measured by the Cooperative General Science Test, was in favor of all academic pupils.

The next question raised was whether the general science curriculum better prepared the academic pupils to answer the test items on the Cooperative General Science Test, Revised Series, Form Q. In order to check this hypothesis, an analysis of the test was made to find the curricular areas in which each item was normally taught.

The Item Analysis of the Test

The item analysis indicated that of the 101 questions on the entire test:

36 were in the subject area of biology
31 were in the subject area of physics
14 were in the subject area of chemistry
11 were in the subject area of earth science, and
9 were classifiable in two or more of the above areas

How much influence did the 36 biology items have on the superior achievement of the academic pupils in Group A? To find this, 50 test papers of academic pupils and 50 test papers of vocational pupils were selected at random from those of Group A. The same was done for Group B. Subscores were obtained for each student on the 36 biology items, the 31 physics items, and for the remaining 34 test items. Table III below indicates the relative achievement of the academic and vocational pupils in Group A and in Group B on the test items in the various subject areas.

An examination of Table III indicates the academic pupils in Group A scored higher in all subjects except physics. In Group B, the academic pupils scored higher in all subjects. Were these differences statistically significant? To find this, the t test was made. The only significant difference found was in favor of the academic pupils in Group A in the subject area of biology. These data for the tests of significance are presented in Table IV which appears on the following page.

TABLE III

A Comparison of the Mean Scores of Academic and Vocational Pupils in Group A and in Group B on Test Items Grouped by Subject Content

Subject Matter	No. of Items	Group A		Group B	
		Academic	Vocational	Academic	Vocational
Biology	36	22.12	17.04	18.46	16.62
Physics	31	10.50	11.28	11.48	10.72
Other	34	11.68	9.76	10.02	8.82

Summary and Suggestions

In summary, the following observations seem pertinent toward drawing a conclusion in regard to the influence of curriculum background and the subject matter content of the test items:

1. The academic pupils of Group A made significantly higher scores on the Cooperative General Science Test (Table II).
2. Of the 101 test items, 36 were in the subject area of biology.
3. On the sub-sections of the test, grouped according to subject matter, the only significant gain was made by the academic pupils of Group A in the area of biology (Table IV).
4. The previous curriculum of the academic pupils of Group A was rich in biology experiences; for Group B it was not.

In view of these data, it is reasonable to conclude that the higher scores of the aca-

TABLE IV

THE SIGNIFICANCE OF THE DIFFERENCES IN THE MEAN SCORES OF GROUPS OF TEST ITEMS ARRANGED BY SUBJECT MATTER CONTENT—COOPERATIVE GENERAL SCIENCE TEST, REVISED SERIES, FORM Q

Subject Matter Field	No. of Pupils	Mean	SD	SE_M	D	SE_D	t	P
Group A								
Biology								
Academic	50	22.12	5.92	.846	5.08	1.134	4.480	P .01**
Vocational	50	17.04	5.29	.755				
Physics								
Academic	50	10.50	7.62	1.089	.78	1.318	.592	.60 P .50
Vocational	50	11.28	5.20	.743				
Others								
Academic	50	11.68	6.78	.969	1.92	1.269	1.513	.20 P .10
Vocational	50	9.76	5.74	.820				
Group B								
Biology								
Academic	50	18.46	5.29	.756	1.84	1.212	1.518	.20 P .10
Vocational	50	16.62	6.63	.947				
Physics								
Academic	50	11.48	4.80	.686	.76	1.098	.692	.50 P .40
Vocational	50	10.72	6.00	.857				
Others								
Academic	50	10.02	4.80	.686	1.20	1.107	.980	.40 P .30
Vocational	50	8.82	6.08	.869				

** Highly Significant.

demic pupils of Group A on the Cooperative General Science Test, Revised Series, Form Q, were due to their having studied more biology in their prevoius curriculum and to the fact that over 36 of the 101 test items required a knowledge of biology.

The value of more careful interpretation of statistical findings seems evident. Upon first examination, the academic pupils as a whole showed a statistically significant superiority over the vocational pupils. However, when the academic and vocational pupils with the same curricular background were separately matched in Group B, no significant difference in achievement was detected. When academic and vocational pupils with different curriculum background were separated into Group A, the academic pupils showed a significant superiority on the Cooperative General Science Test. This test was found to be heavily weighted with biology items. The academic pupils of Group A had a preparatory curriculum rich in biology topics and it is reasonable to conclude that these two factors caused the academic pupils of Group A to achieve a statistically significant superior mean score.

The initial overall results were misleading and led to the overgeneralization, namely, that the mean score of the academic pupils on the whole was significantly superior to that of the vocational school pupils on the whole. However, when differences in curriculum background and the subject composition of the test were taken into account, it was possible to prove that superiority of one group could be attributed to two specific conditions and that if either one of these conditions were removed, the superiority would no longer prevail.

Finally, the study illustrates the principle that the size of the sample is not always the most important consideration. Special qualities or biases of samplings must be considered as well. Numbers are not enough —interpretation begins where statistics end.

A SYNTHESIS AND EVALUATION OF OBJECTIVES FOR A COURSE IN COLLEGE BIOLOGY *

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With the development and subsequent growth of the general education program in American colleges there have been changes in the objectives of many elementary courses. These changes have been motivated by a realization that an education should be related among other things to the needs of the students. The traditional introductory course was primarily an introduction to a specialized field. In recent years there has been a trend toward general education courses designed to meet the needs of the non-specialist. A general education program was inaugurated at Michigan State College in 1945. One of the seven general education courses offered was a course in Biological Science.

It was the purpose of this study (1) to determine the instructional aims of the staff of Biological Science at Michigan State College, (2) to secure ratings of these objectives by a) the staff of Biological Science at Michigan State College, b) a group of faculty members of Michigan State College who were not members of the department of Biological Science, c) a group of senior students who had completed Biological Science in their freshman year, d) a group of students who had not previously taken Biological Science, and e) groups of students completing each term of the three terms of the course, and (3) to interpret these ratings in order to determine the relative importance of the objectives to a) the teaching staff and b) the students.

As a preliminary step in this study the members of the department of Biological Science of Michigan State College were asked to submit lists of specific objectives which they believed were important in the teaching of a course in biology in a general education program. These objectives were then formulated in terms of desired outcomes of student behavior. The following rating sheet was derived from this list of objectives:

> The purpose of this study is to find out what you believe the aims (objectives) of this course in basic biology should be. The objectives listed below have been compiled from a list presented by the members of the staff of the department of biological science. We should like to have you check them in order to determine how important each of these objectives is to you. Mark those which you believe to be the most important with a 1. Those which are the least important to you mark with a 5. Mark the rest 2, 3, or 4 depending upon whether you consider them to be quite important, of average importance, or relatively unimportant. If you do not know what a statement means mark it with an X.

Key

1. Those which are the most important.
2. Those which are quite important.
3. Those which are of average importance.
4. Those which are relatively unimportant.
5. Those which are of the least importance.

X. Those which you do not understand.

PLEASE READ THE ENTIRE LIST OF OBJECTIVES BEFORE RATING THEM

Rating

( ) 1. To acquire a vocabulary of useful biological terms.

( ) 2. To acquire knowledge of some of the basic laws of biology.

( ) 3. To become familiar with biological facts which will lead to more healthful living.

( ) 4. To become familiar with biological facts which will contribute toward social good.

( ) 5. To understand the relation of man to his environment.

( ) 6. To understand the relation of structures to their functions.

( ) 7. To learn to apply the basic laws of biology; for example, the law which states that only green plants have the ability to manufacture food emphasizes the dependence of all animals including man on plant life.

* Paper presented at Twenty-Sixth Annual Meeting of The National Association for Research in Science Teaching, Atlantic City, New Jersey, February 16, 1953.

( ) 8. To acquire the ability to detect and state a problem.
( ) 9. To learn to formulate hypotheses (possible solutions to a problem).
( ) 10. To acquire the ability to plan experiments to test hypotheses.
( ) 11. To learn to make accurate observations.
( ) 12. To learn to organize the facts obtained from observations and experiments.
( ) 13. To learn to read and construct graphs and tables.
( ) 14. To learn to interpret facts, that is to draw conclusions.
( ) 15. To learn to use scientific apparatus, such as the microscope.
( ) 16. To become able to recognize true cause and effect relationships, that is to learn to avoid making unscientific rationalization. For example, to recognize that most diseases are the result of infection, not a punishment for sin.
( ) 17. To learn to distinguish a fact from a theory.
( ) 18. To learn to transfer the method of scientific thinking to one's own problems and to social problems.
( ) 19. To acquire the ability to recognize important biological problems which are still unsolved, such as the cause of cancer, etc.
( ) 20. To develop an attitude of openmindedness, that is, a willingness to accept the results of objective observations.
( ) 21. To develop freedom from superstition.
( ) 22. To develop a willingness to suspend judgment until sufficient facts are gathered.
( ) 23. To develop freedom from prejudice.
( ) 24. To develop intellectual curiosity.
( ) 25. To become acquainted with the nature and extent of the professional fields of biology, such as, forestry, entomology, zoology, etc.
( ) 26. To develop an appreciation of the esthetic values of nature; that is, to appreciate the artistic elements of biology.
( ) 27. To acquire a background for avocational reading.
( ) 28. To acquire other avocational interests such as nature study, etc.
( ) 29. To acquire biological information and techniques which will be of value in the formation of a satisfactory philosophy of life. For example, an understanding of evolution, and of interrelationships of living things may affect one's philosophy of life.
( ) 30. To become familiar with the sources of biological literature.
( ) 31. To appreciate the economic values of biology.
( ) 32. To develop an appreciation of the efforts, hard work, and accuracy that are necessary in any scientific investigation.

The rating sheet was presented to the twenty-six members of the department of Biological Science of Michigan State College in May, 1947. The rating sheet was sent with a letter explaining the purpose of the study to 100 of the teaching faculty, selected at random from the Faculty Directory of Michigan State College in January, 1948. Of this group 53 returned the questionnaire.

The rating sheet was presented to five groups of students. The course in Biological Science at Michigan State College was given for the first time during the academic year 1944–45. In January, 1948, the rating sheet was sent with a letter explaining the purpose of the study to 140 students, most of them seniors, who had taken the course the first year it was offered. Replies were received from 52.1 per cent. Of the replies received twelve or 16.4 per cent were from men, 61 or 83.6 per cent were from women students. The per cent of women in the class the first year was very high due to the war.

The rating sheet was given in September, 1947, to 298 students entering the first term of the course to obtain ratings from a group of students who had not had any biology in college. Of this group, 32.9 per cent were women students, while 67.1 per cent were men. The group ranged in age from sixteen to thirty years of age.

The rating sheet was presented at the close of spring term in May, 1947, to three groups of students enrolled in Biological Science. Three hundred and twenty-five of these students had completed the first term of the course, 312 had completed the second term of the course, and 319 had completed the third term. Of the first term group 87.5 per cent were men, 12.5 per cent were women. The group ranged in age from 17 to 37 years of age. Of the second term group 88.8 per cent were men, 11.2 per cent were women. This group ranged in age from 17 to 37 years of age.

In order to treat the data obtained in this study in terms of types of objectives which were of major impotrance to the various groups studied these objetcives were classi-

fied. The classification was a modification of the one presented in the Forty-sixth Yearbook.[1] The classifications used were, knowledge, understanding, instrumental skills, problem solving skills, attitudes, interests, and appreciations.

In order to present the objective in tables and graphs, the objectives were abbreviated. The abbreviations used are presented in parentheses after the objectives.

CLASSIFICATION OF THE THIRTY-TWO OBJECTIVES OF THE RATING SHEET

I. Knowledge
1. To acquire a vocabulary of useful biological terms.
(vocabulary)
2. To acquire knowledge of some of the basic laws of biology.
(basic laws)
3. To become familiar with biological facts which will lead to more healthful living.
(healthful living)
4. To become familiar with biological facts which will contribute toward social good.
(social good)
5. To acquire biological information and techniques which will be of value in the formation of a satisfactory philosophy of life.
(philosophy)

II. Understandings
1. To understand the relation of man to his environment.
(man to environment)
2. To understand the relation of structures to their functions.
(structures to functions)
3. To learn to apply the basic laws of biology.
(apply laws)
4. To learn to distinguish a fact from a theory.
(fact from theory)

III. Instrumental skills
1. To learn to make accurate observations.
(accurate observations)
2. To learn to read and construct graphs and tables.
(graphs and tables)
3. To learn to use scientific apparatus.
(scientific apparatus)

IV. Problem Solving skills
1. To acquire the ability to detect and state a problem.
(state problem)
2. To learn to formulate hypotheses.
(formulate hypotheses)
3. To acquire the ability to plan experiments to test hypotheses.
(plan experiments)
4. To learn to organize the facts obtained from observations and experiments.
(organize facts)
5. To learn to interpret facts, that is to draw conclusions.
(interpret facts)
6. To learn to transfer the method of scientific thinking to one's own problems and to social problems.
(scientific method)

V. Attitudes
1. To become able to recognize true cause and effect relationships.
(cause and effect)
2. To develop an attitude of openmindedness, that is a willingness to accept the results of objective observations.
(openmindedness)
3. To develop freedom from superstition.
(freedom from superstition)
4. To develop a willingness to suspend judgment until sufficient facts are gathered.
(suspend judgment)
5. To develop freedom from prejudice.
(freedom from prejudice)
6. To develop intellectual curiosity.
(intellectual curiosity)

VI. Interests
1. To become acquainted with the nature and extent of the professional fields of biology.
(professional fields)
2. To acquire a background for avocational reading.
(avocational reading)
3. To acquire other avocational interests.
(avocational interests)
4. To become familiar with the sources of biological literature.
(biological literature)

VII. Appreciations
1. To acquire the ability to recognize important biological problems which are still unsolved.
(unsolved problems)
2. To develop an appreciation of the esthetic values of nature.
(esthetic values)
3. To appreciate the economic values of biology.
(economic values)
4. To develop an appreciation of the efforts, hard work and accuracy that are necessary in any scientific investigation.
(accuracy of science)

The percents of individuals giving each rating were calculated separately for each of the seven groups to whom the rating

[1] *Science Education in American Schools*, Forty-sixth Yearbook of the National Society for the Study of Education, Part I, pp. 28–29. Chicago: University of Chicago Press, 1947.

sheet was presented. Means of the ratings were also calculated. The staff of the department of Biological Science was designated as "staff", while the members of the faculty of Michigan State College to whom the rating sheet was sent was designated as "faculty". The group of students who took Biological Science the first year it was offered was indicated as "seniors". The group indicated as "pre" refers to those students beginning the course in Biological Science, who had not had any previous course in biology at the college level. It will be recalled that the rating sheet was presented at the end of the term to groups of students finishing the first, second, and third terms of the course. Biological Science is designated in the Michigan State College catalogue as Basic 121, 122, and 123, therefore the first term group was called "121", the second term group "122", and the third term group "123".

A portion of the data gathered in this study is presented graphically in Figure 1. Since the student groups were in most cases very similar, the 121 group was chosen as the most representative of the student groups and their responses were used in the construction of this figure.

The per cent of individuals giving the objective a one rating was used as the basis of comparison for Figure 1. The percentage rating the objective either very important or quite important might have been added together and the graph made on this basis, and in several instances this would have been a better index of the importance of the objective. This method was discarded because in several instances all of the staff ratings were in these two categories and this would have made several objectives rated as important by one hundred per cent of the group, thus differences which were apparent in the data would have been lost.

The objectives have been grouped in this graph according to the classification of objectives presented earlier. For each type of objective the objectives are arranged in order of their importance to the staff group. Figure 1 shows that almost all of the objectives are considered more important by the staff of the department of Biological Science than by any of the other groups. The outstanding exception to this is in the importance of biological information leading to healthful living.

There was considerable agreement in the seven groups on certain of the objectives and much diversity of opinion regarding the importance of other objectives. On those objectives which have been classified as knowledge objectives, there was considerable agreement in all of the groups. Of the knowledge objectives there was more diversity of opinion on the objetcive "to become familiar with biological facts which will contribute to social good" than on any other of the knowledge objectives. Of the staff of the department of Biological Science 76.9 per cent rated this as a very important objective, whereas about 40 per cent of the four freshmen groups gave this a rating of one. Of the faculty groups and the seniors about 50 per cent believed this to be a very important objective of the course. It is interesting to compare the response on this goal with the responses to the objective "to become familiar with biological facts which will lead to more healthful living". All groups have rated this objective similarly, but the staff of the department of Biological Science has rated knowledge which contribute to social good considerably higher than it has rated knowledge which contribute to more healthful living, whereas the reverse is true for all other groups.

The objective "to acquire biological information and techniques which will be of value in the formation of a satisfactory philosophy of life," was rated as being more important to the older groups, that is, the staff group, the faculty, and the seniors. The vocabulary objective was considered by all groups to be a relatively unimportant one.

The objectives classified as understandings were rated lower than the knowledge

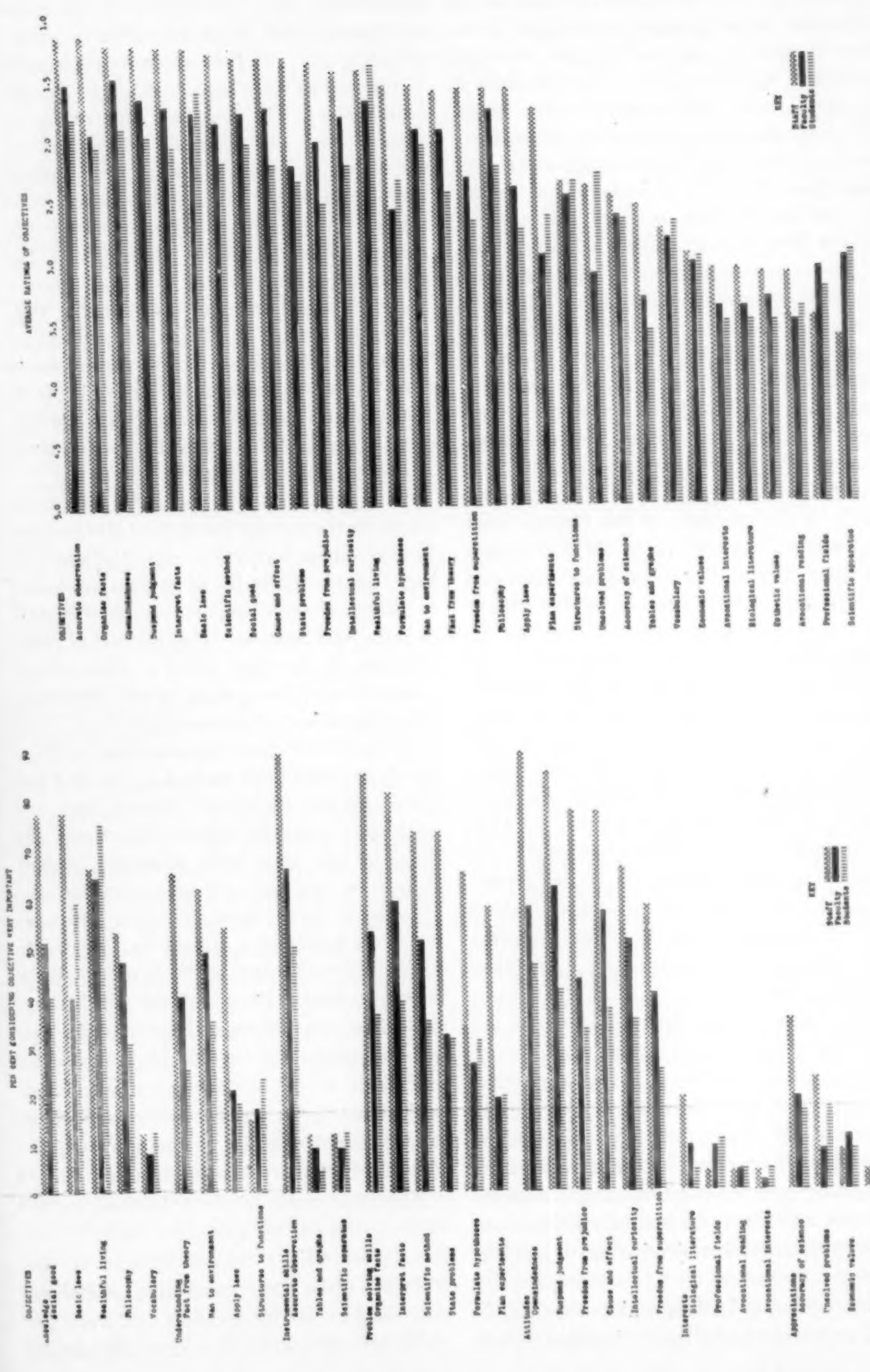

FIGURE 1 AND 2

objectives. It is of particular interest to note that for all groups, knowledge of the laws of biology was rated higher than the ability to apply the laws. For the student groups these differences were great. Whereas about 50 per cent of the students felt that knowledge of principles was a very important objective of biology, only about 15 per cent of them believed that application of these laws was a very important aim.

The responses on instrumental skills are probably the most interesting of the entire study. To make accurate observations was rated the highest of any of the objetcives by the staff of Biological Science, and was rated high by all of the other groups. However, the ability to use instruments which increase the accuracy of observations was the lowest ranking of all of the objectives rated by the members of the biology staff, and was rated very low by all of the other groups. The ability to read and construct graphs and tables, another of the instrumental skills, was consistently rated by the students as a very minor objective.

All objectives related to the scientific method were rated quite high by the staff, most were rated moderately high by the faculty group, and almost all were rated relatively low by the students. As mentioned previously all groups rated the ability to make accurate observations high. An interesting point is that all of the groups rated the ability to organize facts obtained from observations and the ability to interpret facts lower than the ability to make the observations.

The scientific attitudes were rated as being more important objectives by the staff of Biological Science than by any other group. The faculty group is consistently between the staff group and the student groups in their rating of these objectives. However, over 40 per cent of the students felt that an attitude of openmindedness was a very important objective of Biological Science.

In general, objectives which were classified as interests and those classified as appreciations, were considered to be quite unimportant by all of the groups. Surprisingly all of the avocational aspects of the subject were considered to be equally unimportant. It is rather interesting to observe that the objective "to appreciate the efforts, hard work, and accuracy necessary for scientific investigation", was considered by all of the groups except the seniors to be the most important of the appreciation objectives.

As is evident from an inspection of Figure 1 the ratings of all groups are rather similar on knowledge objectives, whereas there is considerable discrepancy between the staff and student groups in the ratings of all of the scientific method skills and most of the scientific attitudes.

In Figure 2 are presented the arithmetic means of the ratings for each of the groups. Low numbers indicate a high average rating. In this figure the objectives are listed in order of their importance to the staff of Biological Science. This method of presentation of the data gives a more direct comparison of the ranking of the objectives than the method of percentages.

As is evident from an inspection of Figure 2, the objectives ranked in the first ten places by the Biological Science staff are principally scientific method objectives. Of the first ten, four were scientific method objectives, one was: to make accurate observations, three were scientific attitude, two were knowledge objectives. Seven of the objectives ranked in the first ten places were also among the objectives which were ranked as the ten most important by the faculty group. Of the ten highest ranked objectives of the seniors seven were also ranked among the top ten by the staff. The students ranked eight of the same objectives as the faculty among their top ten.

The rank order of the objectives for all of the groups is presented in Table 1. Of the ten objectives ranked highest by the students, three were knowledge objectives, one was accurate observation, two were scientific attitudes, three were scientific method

TABLE I

RANKINGS OF OBJECTIVES BY FIVE GROUPS IN ORDER OF IMPORTANCE OF OBJECTIVES TO STUDENTS

Objectives	Students	pre	Seniors	Faculty	Staff
Healthful living	1	1	1	4	12½
Basic laws	2	2½	2	8	5½
Accurate observations	3	2½	4	2	1
Openmindedness	4	10½	5	1	3½
Suspend judgment	5	10½	7½	3	3½
Social good	6	4	3	9	9
Interpret facts	7	5	11	6	5½
Man to environment	8	8	6	12	14½
Organize facts	9	6	13	14	3
Scientific method	10	7	9	11	7
Cause and effect	11	13	10	5	9
Philosophy	12	9	7½	7½	18½
Intellectual curiosity	13	12	12	10	12½
Structure to function	14	15	15	19	21
Formulate hypotheses	15	16	28	20	14½
State problems	16	18	20	16	9
Fact from theory	17	14	14	13	16½
Freedom from prejudice	18	20½	18	15	11
Unsolved problems	19	29	21	17	16½
Accuracy of science	20	23	17	22	23½
Freedom from superstition	21	17	19	27	22
Vocabulary	22	19	23	21	25
Apply laws	23	24	16	18	18½
Plan experiments	24	22	25	23	20
Scientific apparatus	25	20½	26	24	32
Economic values	26	26	22	25	26
Professional fields	27	25	24	26	31
Avocational reading	28	28	27	32	29½
Esthetic values	29	27	31	29	29½
Avocational interests	30	31	29½	31	27½
Biological literature	31	30	29½	30	27½
Graphs and tables	32	32	32	28	23½

objectives, one was an objective which had been classified as an understanding. As has been pointed out previously the outstanding difference between the student groups and the staff group was the placement of the objective related to the knowledge of facts which should lead to more healthful living. All of the student groups ranked this as the most important objective, whereas it was 12½ on the staff ranking. In the faculty rankings it was in fourth place.

The group of students who were beginning biology ranked the scientific attitudes such as openmindedness, suspended judgment, and freedom from superstition much lower than any of the other groups ranked them. The seniors (who incidentally did not hear anything about the scientific method when they took the course in biological science; it had not at that time been included as a major course objective) ranked most of the scientific method objectives lower than any of the other groups had ranked them.

As indicated in Table 1, the ten lowest ranking objectives are principally those objectives which have been classified as appreciations and interests. In general, all groups ranked the same type of objectives among the lowest ten. However, the ability to apply principles appears in the last ten of the freshmen student objectives, whereas the seniors seem to find this a moderately important objective.

In general, all of the student groups were similar in their rating of the objectives. A study of sex differences revealed trends, which, however, were not statistically significant, hence may have been due to chance. These trends might indicate that the women students considered that knowledges for

healthful living, social good and for a satisfactory philosophy of life were more important than the men considered them to be, while the men rated knowledge of the basic laws of biology higher than the women students rated this objective.

In general, the men rated the scientific method skills higher than the women rated them, whereas the women rated the scientific attitudes higher than the men. The men rated the professional aspects of biology and the economic values higher than the women rated them.

The outstanding committee reports on objectives of science teaching have stressed the importance of teaching the scientific method, the importance of teaching general concepts, and the social importance of science. An inspection of Figure 1 and Figure 2 indicates that the staff of the department of Biological Science is in agreement with the objectives as formulated by the outstanding men in the field of science teaching; these objectives have all been rated high by the staff group.

The students, however, consider that the important objectives are those of subject matter as was also found by Noll[2] to be true of many educators in his investigation of stated objectives in text books, courses of study, etc. It will also be recalled that the study of Hunter and Spore[3] showed that there had been a change in the objective which teachers were emphasizing during the ten years between Hunter's first paper on objectives and the one of Hunter and Spore. The later study showed that the teachers were more concerned with objectives other than pure subject matter than they had been ten years earlier. It is encouraging that the teachers have changed. If they have changed there may be hope that with good instruction and proper motivation, the attitude of students toward non-subject-matter objectives will also change.

[2] Victor H. Noll, *The Teaching of Science in the Elementary and Secondary Schools.* New York: Longmans, Green and Company, 1938. p. 8.

[3] George W. Hunter and Leroy Spore, "The Objectives of Science in the Secondary Schools of the United States". *School Science and Mathematics,* 43:633–647. October, 1943.

FACTORS OF EFFECTIVENESS IN SCIENCE TEACHING AND THEIR APPLICATION TO THE TEACHING OF SCIENCE IN OHIO'S PUBLIC SECONDARY SCHOOLS * †

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The Problem

THIS study was concerned chiefly with problems which grew out of a determination and validation of factors related to the effectiveness of a learning situation in secondary-school science, and with the application of these factors to the teaching of science in the public secondary schools of the State of Ohio (School year 1951–52). In addition, a summating study was carried forward which was concerned with the relative effectiveness or ineffectiveness of individuals in a forty-teacher sample of Ohio's secondary teachers of science. These teachers were rated in over-all effectiveness, then were rated on their apparent effectiveness with regard to those items in the factor list which were directly applicable to the teacher, rather than being applicable to the teaching situation, the pupil, the school, or the physical surroundings.

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FACTORS RELATED TO THE EFFECTIVENESS OF A LEARNING-SITUATION IN SECONDARY SCIENCE

Factors which were believed to relate to the effectiveness of a learning situation were chosen after a survey of the literature of science education, and after a review of other literature pertaining to education in general and to secondary education in particular. Tentative lists of factors were drawn and were discussed with many individuals, all of whom had an interest in the field under study. After revision, a final list of seventeen "probable" factors was circulated for agreement, disagreement, or comment to representatives of four educational organizations. These included the National Association for Research in Science Teaching, the National Science Teachers Association, The National Association of Secondary School Principals, and the American Association of School Administrators.

The total membership of the NARST was polled because of the fact that almost all of the members of this organization are identified in one way or another with the preparation of science teachers. A selected list of members of the NSTA was chosen because opinions of secondary-school science teachers were believed to be pertinent. The AASA and NASSP were included (random sampling) because the individuals who hold membership in these two organizations are often those who are supervisors of teachers of science in the public schools.

The list of seventeen items is as follows:

1. Other factors being equal, effective learnnig is more likely to occur when the teacher has a broad background of knowledge in the particular science he is teaching as well as in the related scientific areas.

2. Other factors being equal, effective learning is more likely to occur when the teacher has a functional knowledge of how children develop and how learning takes place.

3. Other factors being equal, effective learning is more likely to occur if the teacher knows about, understands, and uses a variety of methods of instruction as opposed to the exclusive use of one or two methods.

4. Other factors being equal, effective learning is more likely to occur when the teacher is living the life of a normal citizen in the community, exerting community leadership appropriate to his educational position.

5. Other factors being equal, effective learning is more likely to occur in our society when the teacher has a well-thought-out and consistent philosophy of teaching and when the teaching practice is consistent with the stated philosophy.

6. Other factors being equal, learning will proceed more effectively when the teacher is skilled in the use of classroom aids and devices, when he is familiar with, has accumulated, and uses teaching materials of various kinds, and when he knows about and uses sources of information beyond the single textbook.

7. Other factors being equal, learning will proceed more effectively when the teacher has established rapport with the learners and when the learners believe that the teacher is well informed and effective.

8. Other factors being equal, learning will proceed more effectively when the major professional interest of the teacher and his major expenditures of time and energy are concerned with teaching and not with some other occupation.

9. Other factors being equal, learning will proceed more effectively when there is rapport and mutual respect between the science teacher and his immediate supervisor.

10. Other factors being equal, learning will be more effective if the teacher is not carrying an excessive load, either by reason of an excessive number of preparations, an excessive number of pupils per day, or an excessive extra-curricular or out-of-school series of responsibilities.

11. Other factors being equal, learning will be more effective in a school which has a wide variety of science offerings than in one which has a very limited number of such offerings.

12. Other factors being equal, more effective learning is likely to occur when the program of the school is directed toward providing for the special needs of the youth of the community rather than when the program is not so directed.

13. Other factors being equal, more effective learning is likely to occur when the program of the school is directed toward providing for the general educational needs of youth than when the program is not so directed.

14. Other factors being equal, learning will proceed more effectively when the learners and the teacher sense the direction of the teaching, when both participate in the planning, and when the learners see the fulfillment of their own aims implicit in the objectives of the course.

15. Other factors being equal, learning will proceed more effectively if the amount and type of laboratory equipment needed to fulfill the aims of the work is present and in operating condition, and if the number and type of aids, devices, supplies, and materials are at hand and in condition to be used.

16. Other factors being equal, learning will

proceed more effectively in a good physical environment than in a poor one.

17. Other factors being equal, learning will be likely to be more effective when considerable attention is given to problem solving, development of critical thinking, and scientific attitudes.

While combined judgment indicated that minor revisions in the wording of certain items were desirable, there was no item in the list which needed to be deleted or which required a major change. Most of the changes which were suggested could be made by revisions of wording tending to make the item more intelligible or less ambiguous.

APPLICATION OF THE FACTORS

The application of the seventeen factors to science teaching in the public secondary schools of Ohio was made by means of data obtained from the Ohio State Department of Education, from the teachers themselves, and from principals, superintendents, high school students, and school patrons. Some evidence was obtained bearing on each of the seventeen factors of effectiveness.

Data related to the formal educational training of all of Ohio's secondary-school science teachers for the school year 1950–51 were obtained by examination of the principals' reports filed in the State Department of Education. These records also furnished information concerning teaching load in terms of number of preparations, experience in terms of years taught, date and type of most recent degree, major and minor areas of teaching, and the frequencies with which the science subjects were taught in the various high schools of the state. Further records in the State Department gave information pertaining to the adequacy of the science equipment in the schools of the state, as well as the prevalence of items of standard equipment in the science rooms of the state's schools. General estimates were similarly obtained concerning the over-all effectiveness of the science room and its attendant equipment.

Data were obtained from the teachers themselves by means of questionnaires sent to every teacher of secondary-school science subjects in the public schools of Ohio. These questionnaires yielded information related to the personal qualities of the teacher, including his formal and informal preparation for teaching, his experience in non-teaching fields related to the teaching of science, his hobbies, his science-related reading, his memberships in science or science-education organizations, his position in church and community affairs, his beliefs concerning his place in the community, and his teaching load. Also included were questions related to teaching methods, physical equipment, use of materials, apparatus, and supplies. Questions were asked concerning the adequacy of the laboratory and science room which paralleled those given in the reports submitted by the State Department of Education.

In a "forty-teacher study" information concerning effectiveness of teaching was obtained by use of informal visits to various schools and by contact with principals, superintendents, teachers, high-school students, parents, and towns-people. Some use was made of a pupil-rating device. This study furnished information concerning overall teacher effectiveness, also concerning effectiveness in each of a number of factors. It sufficed further to point out that the *summation* of a teacher's effectiveness may be greater than the *average* of his effectiveness as judged by reference to a series of factors. Particular strengths appeared to overshadow and negate some weaknesses.

THE FINDINGS OF THE STUDY

Among the findings of the study were some which had considerable importance in their application to the factors of effectiveness. These findings are as follows:

1. In Ohio, there were five and two thirds men teaching science for every woman teacher in the field. This figure varied from one woman to every seven and a third men in the exempted villages to one woman for every four and seven tenths men in the cities. The rural schools were more nearly like the exempted villages in this

respect. Thus science was more likely to be taught by men in the smaller schools than in the larger, although men predominated everywhere.

2. In the county schools, women were more likely than men to be teaching science without a degree (about two and a half times as likely) although the percentage in both cases was quite small. Men in the county schools were more than twice as likely, on a percentage basis, to have their master's degree. The number of doctorates among county science teachers was insignificant.

All teachers in the exempted villages who were teaching any science had degrees. Men were a little more than twice as likely to have a master's degree. There were no teachers with the doctoral degree.

In the cities, the men were a little more likely to have a master's degree. The number of doctorates was not significant.

3. The city teacher was much more likely to have a master's degree than either the county or exempted village teacher. The figure was 49.4% for city teachers, 30.9% for exempted village teachers, and 21.8% for county teachers. These differences existed in spite of the fact that a very great portion of the county science teachers were men principals who were more likely than regular teachers to have a master's degree.

4. Slightly more than two thirds of Ohio's teachers had the bachelor's degree, slightly less than one third the master's. About one percent had no degree at all. The number with a doctoral degree was not significant.

5. County teachers were, by and large, much more recently prepared than were city teachers. In this respect, the exempted village teachers were much more nearly like the county teachers than like city teachers. A teacher in a rural school was more than three times more likely to be a beginner than was one in the city school. Also, city teachers were likely to have received their most recent degrees prior to 1920 almost ten times more frequently than the county teachers. County teachers thus represented a much younger and more recently prepared group of teachers.

6. More than one teacher in every seven in the county schools had no experience prior to the year of the study. About one in every three and a half had one year or less of teaching experience. Less than two in every three had more than two years' experience. Percentages in the exempted villages were somewhat lower, and in the cities only about one in fifteen had one year or less of experience, with less than one in 33 being a beginning teacher.

About one fourth of Ohio's science teachers received their most recent degree within the two years preceding the study.

Over one tenth of Ohio's science teachers were beginning teachers. About one fifth had one year or less, and about three of ten had three years or less of experience.

7. The most recently prepared group of teachers in Ohio from the standpoint of most recent degree was the group of county-school men teachers, with median degree date in 1946. The least recently prepared group was the group of city women, with median degree date in the 1930–34 span.

About one percent of the county teachers (and exempted village teacher) and about ten percent of the city teachers had no degree awarded more recently than 1920.

8. The median number of years taught was in the six to ten-year bracket for both men and women teachers in the county and exempted village schools, in the 21 to 25-year bracket for city men teachers, and in the 26 to 30-year bracket for city women teachers of science.

9. Eighty-five county teachers were teaching science subjects in high school with no college preparation of any kind in any science. More than one of every three such teachers (551 of 1470) presented less than 25 semester hours total preparation in all forms of post-secondary science. These county teachers were more often than the city teachers required to teach a number of sciences.

About one of every 20 exempted village teachers offered no credit at all in science. About one in every three and a half offered 25 semester hours (total) or less.

In Ohio's city schools, 43 teachers of 864, or about one science teacher in 20 presented no credit at all in any science subject.

A little less than one teacher in every four in the city schools had 25 semester hours or less of science credit in total.

10. About one of every thirteen county teachers was teaching with no preparation at all in his major field of science teaching (110 of 1470). More than half had thirty semester hours or less in their major area of science teaching. Thus, twenty-nine of 324 county teachers whose major area of science teaching was biology offered no post-secondary biology credit; five teachers of 81 in the county schools whose major area of science teaching was chemistry offered no post-secondary chemistry credit; twenty-five of 185 teachers in the county schools whose major area of teaching was physics offered no physics credit beyond secondary level.

11. Fifteen of 207 exempted village teachers, or about one in 14 offered no preparation at all in their major area of science teaching. Forty-eight, or about one in four offered 15 semester hours or less. Thus, seven of 70, or one of every ten exempted village teachers whose major area of science teaching was biology offered no college credit in this subject; no exempted village teacher whose major area of science teaching was chemistry offered less than six semester hours of credit in this subject, but three of 31 offered from six to ten hours; one of 29 physics teachers in the exempted village schools (teachers whose major area of science teaching was physics) offered no physics credit. Only two, however, offered less than ten hours.

12. In the city schools, 54 teachers of 864, or one in 16, had no science preparation in the field of their major area of science teaching. Some-

what less than half had 30 semester hours or less in the field of their major area of science teaching (363 of 864).

In the city schools, 17 of 299 teachers whose major area of teaching was biology had no biology credit at post-secondary level, with 43 of 299 having had 15 or less. Thus one in 17 had no credit, and about one in seven had a limited amount of credit.

In chemistry, nine of 152 city teachers whose major area of science teaching was in chemistry had no chemistry credit. Twenty-three had 15 hours or less.

In physics in the city schools, five teachers of 98 whose major area of science teaching was in this field, had no physics credit. Twenty-five of 98, or about one fourth of the teachers had 15 hours or less.

13. A total of 139 teachers in Ohio were teaching scientific subjects in the high schools with no college credit in any science. In addition there were 140 teachers who may or may not have had any science credit as their records were so incomplete as not to permit judgment. These figures are based on a total of 2541 teachers.

14. Of all teachers, 389, or 26.46% in the county schools; 47, or 22.70% in the exempted village schools; and 208, or 24.07% in the city schools, had preparation in only one science. These numbers are in addition to those who had no preparation in any science. Thus about one teacher of science in Ohio out of every three either had no science at all or had preparation in only one science area.

15. Preparation of the county teachers who taught general science differed little from that of other county science teachers.

In the county schools, 186 of 558 teachers who taught general science offered no biological science credit.

About one in three (178 of 558) county teachers teaching general science offered no physical science credit.

Scarcely any county teachers of general science offered any preparation in earth science.

About one general science teacher in every eight in the county schools offered any college credit in general science, (70 of 558).

16. In the county schools, the smaller schools were more likely to have poor science rooms. In the county schools, one science room was rated excellent, 32 superior, 385 satisfactory, 288 fair, and 94 poor. Thus almost half ranked lower than satisfactory. In some schools science rooms were non-existent. These were chiefly the smaller schools.

In exempted villages, conditions were better than in the county schools, but there were three poor science rooms and thirteen fair, or almost one in five rating less than satisfactory.

In the cities, 28 of 257, or a little more than one in ten science rooms was rated less than satisfactory.

17. In the matter of certain items of standard equipment, county schools ranged from 3% not having running water to almost 80% not having germinating beds, with the median lack for the list of standard equipment standing at 32%. Exempted villages ranged from 0% not having three of the most common items to 55% not having germinating beds, for a median for all items of 18.52%. The city schools ranged from a low of 0.72% on two common items to a high of 32.70% on germinating beds. The city median stood at 7.40%. Thus in the matter of certain items of standard equipment, city schools were in far better condition than were either of the other two types of schools, so far as most items were concerned, and exempted villages were in better condition than were county schools.

18. Some 24 schools of 509 in the counties possessed nothing that could be distinguished as a science room.

19. Of the 1062 schools whose records were available, 233 cases were found in which the local school executive or principal was teaching one or more classes of science. All of these were in the county schools except 19 which were in the exempted villages.

20. Of 815 county schools, 291 had only one person teaching science. In many of these the one person was the principal. In many others it was the coach.

21. Teachers in Ohio's smallest group of county schools (enrollments 1–25 per grade), were required to teach a very wide variety of science and non-science subjects, with 60% of the teachers having five or more preparations per day. This percentage dropped as the size of the school increased, so that the average county high school teacher of science subjects had four preparations per day or less, however over 30% of all county teachers had six, seven, or eight preparations per day. In the exempted villages, the median preparation load was three, but a little more than one teacher in 20 had five or more preparations. The median number of preparations in Ohio's city high schools was two, but some had as many as seven preparations. A negligible percentage had more than four, however. The average number of classes taught per day was about five in all classes of schools. It should be remembered that many of these were double-period classes (or seven-period-per-week classes).

22. Science was taught much more frequently (on a percentage basis) by science majors in the city schools than in the county schools. By "science major" is meant an individual who spent the greatest portion of the day teaching science.

23. Of Ohio's smallest high schools, 34 of 372 four-year and senior high schools, or almost one in ten, offered one science only. Additionally, 164 offered only two sciences (at a time). When only one science was given, it was more likely to be general science than any other. When two were given, they were more likely to be general science and physics. In some cases in these two-science high schools, physics and chemistry were alternated. When three sciences were given, they were more than two and a half times as likely to be general science, biology, and physics than any other combination. Many of these small high

schools never offered chemistry because of complete lack of chemical supplies, equipment, and facilities for performing experiments or even creditable demonstrations.

In the medium-sized high schools (county) only four of 329 offered one science only. This was general science in all four cases. The percentage of schools offering three or four sciences was proportionately greater than in the smaller schools. General science, biology, and physics (as a combination) was about twice as likely to be offered as any other combination.

Conservation was offered by five of the smaller county high schools, and coal mining science was offered by three of the medium-sized county high schools. Conservation was offered by three of the larger county high schools and coal mining science by one of them.

All exempted village schools offered more than one science, and all but one offered more than two.

All city high schools except one offered more than two sciences. All but 26 offered more than three.

Thirty-nine different sciences were offered in Ohio in addition to the standard four high school sciences. Some of these courses were offered by only one high school, others seemed to be regional in nature. Senior science, for example, was found more extensively in the Cleveland area, botany in the Cincinnati area, conservation in Trumbull county, and coal mining science in Jefferson county. Of these subjects, senior science had the greatest number of devotees (91) with physiology next (35), and with aeronautics (16) and botany (15) next in order.

24. Only one county and exempted village teacher of every six had no significant outside work experience, while the median teacher had more than one type of work experience, with about one in six having had at least three general types of outside work experience having significance for science teaching. In the city schools, most teachers had significant work experience, with about one in eight having had no such experience. About one in every four presented more than two general types of work experience which were considered to be significant.

Teachers in Ohio's county and exempted village schools have had, in general, rather significant experiences outside school from a standpoint of time spent in various types of work which relate to the teaching of science. The median teacher had two or more years of experience of this type. The median city teacher had three or more years of such experience.

25. The county teachers, by and large, had science-related hobbies, although one of every three (165 of 538) claimed no such hobby. Most of those who had hobbies have spent an appreciable length of time in developing the hobby. City teachers were more hobby-minded than were the county teachers, with only one of every six not claiming a hobby which was science-related. They also claimed a longer period of hobby development than did the rural teachers.

26. Most county and exempted village teachers claimed that they had no particular educational experience of an organized nature aside from their formal schooling (357 of 560). The others claimed widely varying types of science-related educational experiences. Again, the city teachers were in slightly better case with 221 of 421 claiming no such experience.

27. Less than one in five of the county and exempted village teachers belonged to any science or science-education organizations or groups. Of those who did belong, more (36) belonged to the National Science Teachers Association than to any other group. In the cities, one teacher of every two and one third claimed membership in some such organization. Here the most common type of organization was the district or state science group with a membership of 87 teachers. However, 52 of these teachers also claimed NSTA membership.

28. Fifteen per cent of the county and exempted village teachers claimed never to read any science or science-education magazines. An additional 12% claimed only occasional reading. More than three of every five of these teachers claimed not to have read any science or science-education books during the two years preceding the study, aside from secondary textbooks of science. Of the magazines read by the county teachers, the "popular science" type of magazine was the most widely listed. Of the city teachers, 8% claimed not to have read any such magazines, and 47% listed no books. The city teachers were more likely to list magazines of the Scientific American or Science News Letter type than were the county teachers.

29. Of the 545 teachers in the county and exempted village schools who answered the question relating to further education of any type, 377 indicated nothing beyond formal schooling. Of the remainder, more (42) listed travel than any other single item. Approximately half of the city teachers listed additional educational experiences, with travel again leading the list.

30. Somewhat less than half of the county and exempted village teachers (43%) held or recently had held positions of leadership in their church. More than 60% of these had held the positions for more than a year. Almost half of the city teachers (49%) held such positions, and more than half of these had held their positions for five or more years.

31. Over half (53%) of the county and exempted village teachers were participating or had recently participated in out-of-school youth activities in a position of leadership. The percentage among city teachers was about the same.

32. About two thirds of Ohio's county and exempted village science teachers reported membership in one or more fraternal, social, or service organizations in their communities. In the cities, the percentage was a little less.

33. About 40% of Ohio's rural and exempted village teachers reported leadership in community drives in the recent past. The percentage in the cities was slightly higher, standing at about 44%.

34. About 72% of rural and county teachers believed that teachers in their communities often assumed leadership in moves for the good of the community. In the cities the figure was about 80%.

35. About three of every four county and exempted village teachers reporting believed that their communities permitted them to lead a normal life. For the cities, the percentage was somewhat over 90%.

36. Only 23 of 558 county and exempted village teachers of science had no extra-curricular duties. For 227 of these teachers, or more than a third, coaching was all or a part of the extra duty, while with 108, administration or supervision entered the picture in addition to other extra-class duties. In the cities, 18 of 411 teachers did not have extra duties. There were 92 coaches, 220 who had clubs of one type or another, and 40 who were administrators or supervisors.

About one in five county and exempted village teachers reporting believed that their extra-curricular load hurt their teaching. About two in five believed that it helped. The rest either had no opinion or believed that it didn't matter. In the cities, one in eight believed that his extra-curricular load was harmful, and again, two in five believed that it helped.

37. Only about one teacher in 20 in the county and exempted village schools, and one in 50 in the city schools, believed that his community work was harmful to his teaching. Almost half in each case believed that it was helpful. The rest either didn't know or qualified their answers.

38. In county schools, exempted villages and cities, about half of the teachers reported that they did no extra-contractual work for pay during the school months. In all three categories about one teacher in five reported working more than 11 hours per week for pay outside school hours.

39. The median Ohio teacher of science had a pupil load, aside from study halls, or from 101 to 125 pupils per day. The county teachers were near the low end of this range, the city teachers near the high end. It is well to remember that these figures included only total number of pupils faced and did not take into account the fact that some classes were double-period sections.

The median preparation load reported by county teachers was four per day. This tallies with the load as recorded from state department of education data. The number of study halls was one per day. The median number of preparations reported per day by city teachers was two, which also tallies with state department figures. Also with city teachers, the median number of study halls was one per day.

40. Half of the state's teachers reported that they used movies frequently in their teaching, with about one in 20 reporting no use, the rest occasional use. The percentage of users was reported to be somewhat larger in the cities.

More than nine of every ten city teachers, and about 84% of the county and exempted village teachers reported that they could operate a standard 16-millimeter movie projector.

About seven of every ten teachers in both county and city reported that they could make minor repairs and adjustments to a movie projector.

41. Filmstrips and slide-films were used frequently as teaching devices by only one teacher in four. About half of the teachers reported occasional use, the rest reported no use at all. The percentage of frequent users was larger in the cities, of non-users was larger in the county and exempted village schools.

Almost all of Ohio's teachers of science claimed to be able to operate a filmstrip projector. Only one in 20 of the city teachers, and one in 12 of the county teachers claimed not to be able to do so.

42. Seven of every ten city teachers and somewhat more than this number of the county and exempted village teachers of science claimed that they could make home-made slides which have value in teaching secondary science.

A little less than a third of the county and exempted village teachers, and a little less than two fifths of the city teachers of science claimed that they did make and use home-made slides in their science teaching.

43. About three of five city teachers, and about two of three of the county and exempted village teachers claimed that they were able to use some kind of recording or transcribing device.

Only a small percentage of teachers (6% in the city and less than 4% in the other schools) claimed that they used recordings or transcriptions frequently in their teaching. A majority of the teachers (60% in the city and over 70% in the county and exempted village schools) claimed never to use such teaching devices.

44. Almost three of every five city teachers claimed to make frequent use of models, exhibits, dioramas, etc., as compared with about two of every five in the smaller school. About 4% of the city teachers never used such devices as compared with about 6% of the rural teachers who claimed never to use them.

45. Less than one of every four city teachers of science, and less than one of every six county and exempted village teachers frequently made use of pupil assistance in setting up models, exhibits, etc., according to their claims. On the other hand, a larger percentage of county teachers (69.80% as compared with 62.21%) claimed occasional use of such student help. Almost the same per cent in each case (about 14%) claimed that they never used students for this purpose.

46. In both rural and city schools, approximately three of ten teachers said that they regularly either devised, or aided pupils to devise, needed laboratory and demonstration equipment which was not available. About six in ten said that they did so occasionally, and less than one in ten said not at all. In a minority of these last cases, the teacher inserted the comment that his laboratory was so well furnished that there never was need to devise equipment.

47. About 85% of the city teachers and 70% of the county teachers said that they felt

thoroughly competent in their science laboratories. About 13% of the city and almost 29% of the county and exempted village teachers said that they felt only partially competent, while something less than 2% of the teachers in each case said that they felt totally incompetent in their science situations.

48. About 15% of all of the teachers claimed that they made frequent use of field trips. About 61% of the city teachers and about 71% of those from the smaller schools claimed to make occasional use, with approximately one fourth of the city teachers and 14% of the others claiming that they made no use at all of field trips. Administrative objection or administrative difficulty was one of the leading causes mentioned by city teachers. Distance to points of interest was a leading cause advanced by others.

49. About 56% of the city teachers and 47% of the rest claimed that they made frequent use of libraries in their science teaching. A negligible number of city teachers and 2½% of the other teachers claimed no use of libraries at all.

About 57% of the city teachers and half of the county teachers reported frequent use of printed materials other than textbooks and workbooks. Only about 1½% in each case reported no use of such additional printed materials.

50. Somewhat over 60% in each case were one-textbook teachers according to their report, a little over 10% said that they used two texts, while a little over one in four reported using three or more textbooks.

51. Community resources were used frequently by more than 15% of the city teachers and a little less than one in ten of the other teachers, according to their statements. About one-fifth of the city teachers and nearly 30% of the others claimed never to draw community materials into their science teaching.

52. More than 71% of the city teachers and about two of every three county and exempted village teachers claimed that they were familiar with the state's sources for supplementary teaching materials in science.

53. Only about 5% of the city teachers, and 7% of the county and exempted village teachers (many of them primarily agriculture teachers) claimed frequent use of state-prepared materials for teaching science. About half of the teachers of the state in both classes claimed to use them occasionally.

54. About four of every five teachers in city, county, and exempted village groups claimed to be familiar with two or more sources of printed tests in their science fields.

About one third of the city teachers and about one fourth of the other teachers claimed to make frequent use of tests other than those of their own construction. About half of the city teachers and two thirds of the county teachers claimed to use them occasionally, with 17% of the city teachers and 10% of the others claiming never to use them.

55. About 22% of the city teachers, and half that percentage of the other teachers claimed to be currently using a resource unit of one kind or another. About 35% in each case claimed to have used one within the preceding two years. Thus about 42% of the city teachers and 53% of the other teachers said that they never had used one. From the appended comments, many teachers never had heard the term used and had no idea concerning what was being queried.

56. About two thirds of the city teachers, and a little more than three fifths of the other teachers claimed familiarity with sources of free and low-cost teaching aids in science.

About 17% of the city and 10% of the other teachers claimed to make frequent use of listings of free and low-cost materials. Approximately 43% of the city, and 46% of the other teachers claimed occasional use. Thus two of five city teachers and a little more than that number of other teachers claimed no use of sources of free and low-cost science teaching aids.

57. Approximately seven of ten city teachers and just a little over half of the other teachers claimed familiarity with the work of Science Clubs of America.

Only three of every ten city science teachers, and two of ten of the other teachers claimed to make any use whatever of the teaching and club materials prepared by the Science Clubs of America.

58. About 60% of the city teachers, and slightly over 40% of the other teachers claimed to have any knowledge about the work of the Junior Academy of Science.

About 18% of the city teachers, and 6% of the others claimed to have had any students participate in a junior academy fair during the preceding two years.

59. Approximately one of five city teachers of science, and one of seven of the others claimed to make frequent use of government publications which are of use to science teachers. Approximately 60% in each class claimed to make some use of these materials.

60. Approximately 11% of the teachers in both groups claimed that they always followed the organization of a particular textbook in developing their teaching plans. Approximately 73% of the city and 80% of the other teachers said that they usually did, with about 12% of the city teachers and 8% of the other teachers saying that they never followed such organizations.

61. Over half of the city teachers and almost half of the others said that they alone planned the work of the course in all cases. Approximately 35% of the city teachers and over 48% of the other teachers claimed that the students helped, while almost 11% of the city teachers wished to make qualified answers which, for the most part, stated in rather general terms that some slight help was permitted but that the teacher set the direction of the course.

62. More than half of the city teachers, but only about one of every five of the teachers in the smaller schools believed that their science rooms were adequate. Less than 2% of the city teachers, but over 14% of the county and ex-

empted village teachers believed that their science rooms were totally inadequate.

63. While the city teachers reported the physical facilities in their schools to be good in 56% of the cases, less than 30% of the county and exempted village teachers so reported. Only a little more than 6% in the cities believed that their facilities were in poor condition, while in the other schools the percentage was almost 22%.

64. Approximately half of the cities reported their laboratory furniture to be in good condition, with 14% reporting "poor". In the smaller schools, the "good" figure was a little more than 28%, and the "poor" was almost 24%.

65. In a little more than four reports of every five, science equipment in city schools was reported as being in generally usable condition, whereas in the other schools the figure was 54%. Additionally, whereas a negligible number of city teachers reported very little equipment available, approximately 2½% of the county and exempted village schools reported this condition.

66. Whereas a little less than 3% of the city teachers reporting indicated that there had been no science expenditures in their schools during the preceding two years, almost 15% of the county and exempted village submitted such a report. While a great many teachers did not answer this question, or plead ignorance regarding the amount spent, in both city and county schools, the median amount spent was in the range from one cent to one dollar per pupil for the preceding two-year period.

67. In all groups of schools about 55% reported that their rooms were well painted, about one of three said fairly well painted, and the remaining 12% indicated that their rooms were poorly painted.

68. Janitorial services were rated good by slightly more than half of the teachers, city and county alike, fair by about 32%, and poor by about 15%.

69. Conditions of heating and ventilation were reported good by about 46% of the teachers in all brackets, usually good by about 45%, and poor by some 9%.

70. Rooms were reported equipped with proper shades for good use of the room in carrying out the work of a science class or laboratory by approximately two thirds of the city teachers reporting, and by less than half of those reporting from the other schools (49%).

71. Not more than half of the objectives of science teaching as reported by science teachers showed very great insight into or grasp of any recognizable broad philosophy for education of youth in a democracy. Many of the statements, given as sole responses to the question included somewhat limited objectives as, for instance, "preparation for college", or "teaching the course of study".

72. "Factor effectiveness" of teachers seemed, in broad general terms, to be indicative of overall effectiveness.

Particular strengths or weaknesses in any one or more of the somewhat "intangible" factors such as pupil-teacher rapport, may overcome contrary ratings on other more tangible factors.

73. Non-suitability to teaching, some of which might have been detected during the course of any extensive guidance program in the teacher-training institutions appeared to be at the root of much poor compatibility between teachers and pupils on the one hand, and teachers and supervisors on the other.

74. In the sampling of forty teachers, teachers seemed to be succeeding quite well who were overloaded. Teachers also seemed to be successful, if most other aspects were favorable, when they were taking no particular leadership in their community, aside from their work in the school.

Application of Findings to Factors of Effectiveness

An analysis of the preceding findings shows that they offer considerable evidence concerning the conditions of science teaching in Ohio with relation to each of the seventeen "factors of effectiveness" which were chosen for this study. This analysis was made as a portion of the study and was included in the full report of the study.

Recommendations

The following recommendations were an out growth of the study, and were discussed in detail in the complete report:

1. Recommendation was made for further study of pupil-teacher rapport, of philosophies of science teachers, of the place of the science teacher in the community, and of the teaching load. Need was seen also for study of the programs for preparation of science teachers which were being offered by teacher-preparatory institutions, and for development and study with regard to in-service education for science teachers. The position of the science teacher with respect to the core curriculum needs to be clarified.

2. Need was seen for improved programs leading to teacher certification. Such programs should include deeper and broader subject-matter preparation, greater attention to the areas of child development and growth, the development of a broad general educational program, attention to the development of community attitudes, adequate and functional professional preparation, cultural contacts, and work directed toward developing with the prospective teacher his place as a leader in the community.

3. Need was seen for the development of adequate in-service programs of education for those who are not competent teachers and who nevertheless are in the profession.

4. Recommendation was made that the science and science-education associations redouble their

efforts to make teachers acquainted with their benefits.

5. Recommendation was made that Boards of Education in Ohio endeavor to select teachers of science in an intelligent manner, rather than selecting an individual primarily because of his coaching (or other) ability.

6. Boards of education in Ohio are urged to increase radically their budgets for science equipment and supplies. Because of the long neglect of science rooms, it is urged that this spending be placed on an emergency basis.

7. In order that effective programs of science education be developed in the rural areas, it is recommended that the State Department of Education continue with its program of consolidating schools which are so small that adequate curriculums cannot be supported.

CONCLUSION

Although science education in Ohio appeared to be suffering from a number of ills at the time of this study, careful attention to its area of weakness can result in a much improved program in a relatively short time. There were evidences of improvement over conditions found by earlier investigators. Improvement should continue.

A STUDY OF OPINIONS RELATED TO THE NATURE OF SCIENCE AND ITS PURPOSE IN SOCIETY *

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FEW, if any, individuals engaged in education would challenge the statement that a study of science is important in the general education of every college student. When we inquire as to what portions of all the vast realm of scientific knowledge should be included in the curriculum we find that the question is not easy to answer. The body of scientific knowledge has grown to such proportions, and is now expanding at such a rapid rate, that one scarcely knows where to begin with students who have a limited amount of time for this field. Yet we must realize that life in the second half of the twentieth century will demand the solution of problems involving science which are unprecedented in human history.

Much has been written in recent years on the subject of what we should teach in college science courses as well as how we should teach it. Considerable emphasis has been placed on the idea that we need to develop understanding of science and the methods by which scientific knowledge has been obtained. Dr. James B. Conant, in discussing the necessity for an understanding of science by all citizens, has said:

> . . . the remedy does not lie in a greater dissemination of scientific information among nonscientists. Being well informed about science is not the same thing as understanding science though the two propositions are not antithetical. What is needed is methods for imparting some knowledge of the tactics and strategy of science to those who are not scientists.[1]

The purposes of science in the education of those who will not be scientists need careful thought and discussion. Many of us, in stating our objectives for science teaching, have glibly made such statements as, "To promote critical thinking" or "To develop appreciation of the scientific method." We have done little, however, to determine achievement of such objectives.

The American Association for the Advancement of Science has recently indicated some concern about the public attitude toward science and scientists. The current issue of *Scientific American* reports that several addresses and papers dealt with this general subject at the recent 119th meeting

* Paper presented at Twenty-Sixth Annual Meeting of The National Association for Research in Science Teaching, Atlantic City, New Jersey, February 17, 1953.

[1] Conant, James B. *Science and Common Sense*, New Haven, Yale University Press, 1951. p-4.

of this organization held in St. Louis. During 1953 the association will appoint a committee to look for new ways to "increase public understanding and appreciation of the importance and promise of the methods of science in human progress." Maurice B. Visscher, of the University of Minnesota Medical School, suggested in an address that the Association raise funds for an education campaign to protect what he termed "the free enterprise system in ideas" and to oppose the efforts of organizations and individuals "displaying overtly paranoid behavior toward scientists."

This paper does not pretend to answer the critical question of what should be the purposes of science in general education. It is a report of an attempt to determine the opinions and attitudes related to certain aspects of science and its place in our society which are held by several groups of college and high school students.

A set of 26 statements about science, which are included in Table I, was pre-

TABLE I

Mark the following statements with an *A* if you agree that they are essentially true and with a *D* if you disagree or think they are essentially false. Please give your reaction to all statements.

....1. Scientists as a group are more intelligent than those in other lines of work; such as law, business, and farming.

....2. Scientists are likely to be more logical in their approach to problems, even those outside their field of work, than are other professional men and women.

....3. The exactness and impartiality of the scientist in performing and reporting laboratory experiments is probably due in large part to the knowledge that his work will be examined by other competent workers rather than to the fact that scientists are more impartial and objective than other men.

....4. Scientists have advanced knowledge by consistently following, step by step, a definite method called the problem solving formula.

....5. Scientists often make errors and waste much time exploring "blind alleys."

....6. A scientist is likely to be unbiased and objective, not only in his own field of work, but in other areas as well.

....7. The great scientists of the past often made use of lucky guesses or "hunches."

....8. History will show that when scientists make mistakes they are quick to admit their errors when these errors are pointed out to them.

....9. Training in science will definitely help one to make more logical decisions in other fields, such as politics for example. Thus, the study of science is the best education for those who wish to be impartial in their thinking.

....10. Great progress would be made in all fields of human activity if scientific methods were applied to them.

....11. A rapid expansion of scientific programs such as that of the Atomic Energy Commission will make us secure against attack.

....12. Science and scientific research have become essential to modern progress. Since scientists are specialists in this field we should accept their judgment in matters of public policy related to science rather than attempt to educate the public to make decisions on scientific matters.

....13. Science is a difficult subject and can really be pursued profitably only by those of better than average ability.

....14. The fundamental theory which made possible the release of atomic energy was developed in the United States.

....15. The one primary purpose of science in human society is to increase man's control over nature and to increase his ability to use natural resources so as to make life more comfortable.

....16. Science is responsible for much of the evil in the world today because of its application to the production of weapons of war.

....17. Many of the scientific theories of the past have been discarded or modified as they have been found inadequate. However, the theories and laws of modern science are essentially accurate and are likely to endure in their present form.

....18. The scientist can obtain a direct answer to any simple question concerning nature by means of a carefully designed experiment.

....19. Advances in science consist of the accumulation and classification of accurate data.

....20. The observations and measurements involved in scientific experiments are seldom erroneous and the interpretation of results involves little chance of error.

....21. The real advances in science consist of the production of such useful things as radios, automobiles, and drugs.

....22. Science is a highly organized social activity the very existence of which depends upon the ability of experimental scientists to communicate rapidly with each other.

....23. Due to the high cost of scientific research and to the importance of science as a factor in national survival it may be desirable for the federal government to as-

sume responsibility for the financing and direction of all scientific research.

....24. Since scientific research is very expensive it would seem wise to curtail research directed solely toward advancing knowledge and to concentrate on engineering development and the application of scientific principles to practical problems.

....25. It is quite possible that a policy of secrecy regarding scientific research, such as that now in force in the Atomic Energy Program, might work to the long range advantage of science in this country since, if scientists in other nations do not have access to our findings we will soon outstrip them in the race for new knowledge.

....26. Science is valuable only to the extent that it benefits the whole of society in a practical way and thus scientific research should be planned and directed to meet the immediate needs of society.

pared. The basic ideas in many of these statements were suggested by two recent books dealing with the general subject of understanding science. These books are: *Science and Common Sense* by James B. Conant and *The Path of Science* by C. E. Kenneth Mees. These statements were submitted to various groups of students and they were asked to indicate either agreement or disagreement with each one. The development of attitudes toward the ideas expressed in these statements may be important objectives of science teaching.

The college students included in this study may be seen to fit into four definite categories; freshmen and sophomores enrolled for courses in general physical science, seniors in the final semester or quarter of college work prior to student teaching, junior and senior science majors including several pre-medical students, and public school teachers in extension classes. The high school students included were students in a college demonstration school. They were, for the most part, children of businessmen, professional men and landowning farmers. All had completed a minimum of three years of general science in the 7th, 8th, and 9th grades.

The reactions of the various groups of college students to the set of statements about science are summarized in Table II. The percentage of each of the nine groups in agreement with each statement is shown as well as the percentage of the total group of 285 students. Despite the fact that these groups differ considerably in background and training in science there is considerable uniformity in their reactions to these statements. The percentages of the various groups in agreement with each statement are, with few exceptions, fairly close together. The following conclusions seem to be justified on the basis of the data in Table II.

1. These students do not seem to distinguish clearly between pure science with its aim of advancing knowledge and the application of this knowledge to the production of useful devices and products. Fifty-seven per cent of them agree that the real advances in science consist of the production of useful devices such as automobiles and radios.

2. There seems to be a rather disturbing lack of understanding of the necessity for freedom of investigation in science on the part of these students. The fact that almost 53% of these college students would agree that scientific research should be planned and directed to meet the immediate needs of society and almost 46% of them would agree to Federal control of scientific research would seem to indicate a lack of understanding of the necessity for freedom of investigation. Secrecy in science seems to have considerable appeal to these students in view of the fact that 36% of them think that it might work to our long range advantage.

3. The majority of these students consider the primary purpose of science to be concerned with the improvement of man's physical comfort. At the same time, 31% of them think that science is responsible for much of the evil in the world.

4. The faith in our ability to educate the public to make decisions in matters of public policy related to science is not very strong in these students. Forty-two per cent of them think we should accept the judgment of specialists rather than attempt to educate the public to make decisions. It seems a bit ironical that the teachers in this group have no more faith in our ability to educate the public along these lines than does the remainder of the group.

5. This group of students think that scientists are more logical in their approach, and more objective in their outlook, toward problems even outside their field of work than other professional people. They also express considerable faith in the proposition that training in science will make one's thinking more logical, even in such areas as politics.

6. Fifty-nine per cent of this group think that great progress would be made in all fields of human activity if scientific methods were applied to them. However, they take a rather conservative view of the ability of scientists to eliminate

TABLE II

PERCENTAGE OF VARIOUS GROUPS IN AGREEMENT WITH EACH STATEMENT

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
1.	25.0	12.0	14.3	4.7	19.2	37.5	7.7	33.3	24.1	17.5
2.	68.8	52.0	63.0	37.5	92.0	79.2	72.0	70.8	62.0	61.7
3.	50.0	48.0	54.2	47.0	50.0	45.8	50.0	62.5	75.9	53.0
4.	75.0	52.0	63.0	54.6	38.5	33.3	53.8	45.8	51.6	53.3
5.	81.3	88.0	80.0	87.5	92.0	75.0	76.9	87.4	86.2	83.9
6.	56.2	72.0	68.6	37.5	57.7	66.6	73.0	70.8	38.0	65.8
7.	56.2	80.0	68.6	81.2	73.0	70.8	76.9	62.5	69.0	71.9
8.	46.8	48.0	34.3	26.6	11.5	29.1	53.8	62.5	41.4	37.5
9.	59.3	48.0	57.2	26.6	42.3	54.2	38.4	79.1	55.1	48.0
10.	68.8	48.0	51.5	51.6	61.5	70.8	50.0	66.6	79.3	59.6
11.	25.0	12.0	14.3	10.9	26.9	16.6	34.6	33.3	20.7	20.0
12.	40.7	36.0	22.8	51.6	38.5	37.5	57.7	54.1	38.0	42.4
13.	68.8	44.0	31.4	39.0	34.6	37.5	26.9	45.8	17.5	38.6
14.	40.7	28.0	22.8	25.0	26.9	25.0	19.2	50.0	41.4	30.2
15.	96.8	80.0	71.5	87.5	80.8	79.2	80.8	87.4	82.7	83.5
16.	31.2	40.0	28.5	40.6	15.4	20.8	19.2	29.2	41.4	31.2
17.	46.8	40.0	40.0	31.3	26.9	50.0	30.8	54.1	38.0	38.6
18.	50.0	36.0	25.7	15.6	30.8	20.8	15.4	25.0	20.7	25.6
19.	81.2	92.0	77.0	82.9	84.5	79.2	76.9	75.0	51.6	78.2
20.	18.8	32.0	11.4	10.9	11.5	20.8	19.2	16.7	24.1	17.2
21.	68.8	80.0	65.7	53.1	42.3	62.5	38.4	58.3	51.6	57.5
22.	59.3	64.0	22.8	47.0	53.8	54.2	88.5	70.8	75.9	56.8
23.	43.7	52.0	62.8	45.3	26.9	12.5	46.1	70.8	48.2	45.9
24.	18.8	28.0	22.8	12.5	00.0	8.3	34.6	20.8	24.1	18.2
25.	43.7	44.0	40.0	31.3	15.4	16.6	53.8	45.8	38.0	36.2
26.	46.8	52.0	77.0	61.0	15.4	41.6	53.8	62.5	48.2	52.9

I. 32 college freshmen and sophomores in the physical science survey course at Eastern Kentucky State College. (Near the end of the course)

II. 25 college freshmen and sophomores in the physical science survey course at Georgia Teachers College. (Near the start of the course) 11 students with no previous college science; 14 with an average of 10 qtr. hr. mostly biology.

III. 35 college seniors enrolled for student teaching at Eastern Kentucky State College. All have 14 semester hourse of science or less.

IV. 64 college seniors enrolled for student teaching at Eastern Kentucky State College. 54 have 14 semester hours of science or less and 10 have more than 14 semester hours.

V. 26 college juniors and seniors in a general physics course at Peabody College. (Near the end of the course). Approximately half the class are Vanderbilt premedical students. Range of college science credit: 12—160 qtr. hr. Mean: 55 qtr. hr.

VI. 24 college seniors and graduates in Peabody College course in Methods of Teaching High School Science. All science majors or minors.

VII. 26 teachers in an extension class in Philosophy of Science conducted by Eastern Kentucky State College. (At the start of the course)

VIII. 24 teachers in same type group as # VII.

IX. 29 teachers in same type of group as # VII.

X. Combined group of 285 college students.

errors from experiments dealing with natural phenomena and to interpret the results of such experiments without error.

7. A relatively low percentage of this group assert that scientists are more intelligent than those in other lines of work. On the contrary, a relatively high percentage think that scientists often make errors and have made use of lucky guesses in the past.

Table III shows the percentage of the high school students in this study in agreement with each of the statements. These groups agree very closely on many of the statements. The principle differences in their responses and those of the college students may be summarized as follows:

1. A greater percentage of the high school students think that scientists are more intelligent than those in other lines of work.

2. A much smaller percentage of the high school students agree that scientists have advanced knowledge by consistently following a definite problem solving formula. This difference was no doubt due in part to the fact that one group of the high school students had been concentrating on scientific methods in their biology course.

TABLE III

Percentage of High School Students in Agreement with each Statement

	I.	II.	III.
1.	29.4	23.0	25.6
2.	58.9	65.4	62.8
3.	68.8	53.8	58.1
4.	47.1	00.0	18.6
5.	58.9	88.5	76.7
6.	65.2	80.7	69.8
7.	82.3	88.5	86.1
8.	68.8	38.4	48.8
9.	88.2	42.2	60.4
10.	58.9	46.1	51.2
11.	41.1	26.9	32.6
12.	41.1	42.2	41.8
13.	29.4	46.1	39.5
14.	17.7	50.0	37.2
15.	76.5	80.7	79.0
16.	11.8	46.1	32.5
17.	76.5	19.5	41.8
18.	29.4	11.5	18.6
19.	76.5	80.7	79.0
20.	35.3	7.7	18.6
21.	82.3	52.7	67.4
22.	53.0	38.4	44.2
23.	47.1	50.0	48.8
24.	35.3	30.8	32.5
25.	41.1	61.5	53.5
26.	23.5	42.2	34.9

I. 17 high school students (juniors and seniors) in a chemistry course.

II. 26 high school students (sophomores) in a biology course. One of the objectives of this course was the development of understanding of the work of scientists and the methods by which scientific knowledge has developed.

III. Combined group of 43 high school students.

3. The high school students have greater confidence in the objectivity of scientists even outside the field of science, and in science training as preparation for impartial thinking.

4. The high school students regard secrecy in scientific research with considerably more favor than do the college students.

Table IV provides a comparison between two groups of college students differing considerably in the number of science courses completed. Group I consists of 60 college students majoring or minoring in science who have completed 15 semester hours or more of science. Group II includes 225 college students specializing in fields other than science and who have completed less than 15 semester hours of science. The percentage of each group in agreement with each statement is shown in the table. There is little difference in reaction of these two groups to the majority of these statements. The major differences in their reactions may be summarized as follows:

TABLE IV

	I.	II.
1.	25.0	15.5
2.	78.3	58.1
3.	45.0	55.0
4.	35.0	58.2
5.	80.0	84.9
6.	60.0	56.0
7.	76.6	70.6
8.	21.6	41.7
9.	46.7	48.4
10.	65.0	58.2
11.	20.0	20.0
12.	40.0	43.1
13.	36.7	39.1
14.	25.0	31.5
15.	81.3	83.9
16.	20.0	34.2
17.	41.7	37.8
18.	23.3	26.2
19.	81.6	77.3
20.	15.0	17.7
21.	51.6	59.1
22.	55.0	57.2
23.	21.6	52.3
24.	6.7	21.3
25.	16.7	41.3
26.	35.0	60.4

I. 60 college students majoring or minoring in science. 15 semester hours or more of science courses have been completed.

II. 225 college students with less than 15 semester hours of science courses completed.

1. The science majors and minors think scientists more intelligent and more objective in their approach to problems, even outside their field, than do students who have had less training in science. More of the students specializing in science think that scientific methods would result in great progress in all fields.

2. Fewer of the science majors and minors think that scientists have advanced knowledge by consistently following a definite problem solving formula.

3. Fewer of the science majors and minors agree that scientists throughout the history of science have been quick to admit their errors.

4. More of the students not specializing in science think that science is responsible for much of the evil in the world because of the application of science to the production of the weapons of war.

5. Science majors and minors are much more skeptical of Federal control of scientific research than are the students not specializing in science.

6. Fewer of the science majors and minors agree that any centralized control and direction of science would be desirable. They also regard secrecy in science with less favor than do the students not specializing in science.

The responses of these students to this set of statements about science indicate a considerable lack of understanding of science and its place in our society. For the great majority of college students, who will not become scientists or technicians, attitudes toward some of the ideas in these statements will be more important than detailed knowledge of scientific laws. Certainly an understanding of science in the broader sense is dependent upon some knowledge of scientific laws and principles. However, the student in the college science course may fail to see many of the implications of science and its relationships to other fields of knowledge if no specific attention is given to this phase of science teaching. Our science courses should be giving definite attention to the purposes, methods, possibilities, and limitations of science and its relationships to other activities of men.

It seems that further investigation in this area, perhaps by more refined methods, would be profitable. The results of such studies should definitely influence the content of science courses, particularly those which are a part of a general education program.

THE EDUCATION OF HIGH SCHOOL SCIENCE TEACHERS AT MADISON COLLEGE *

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THE main objectives of this study were to discover significant conditions and major problems related to the education of high school science teachers at Madison College, and to draw implications from these conditions and problems for the purpose of recommending changes in basic organization and fundamental policies.

Although this study deals with a specific problem in teacher education within a particular institution, it is believed that the recommendations made are supported sufficiently to make them of general interest in the education of science teachers.

PROCEDURE AND SOURCES

Information for this study was obtained from a questionnaire which was sent to Madison College graduates who were teaching one or more classes in science and who had completed at least eighteen semester hours of work in biology, chemistry, geology, or physics; or in a combination of the aforementioned subjects. The purpose of the questionnaire was to obtain the reactions of the teachers to their education for science teaching at Madison College and to obtain their opinions concerning other items pertinent to the preparation of science teachers.

Data, for all Virginia high schools, were also secured concerning subjects taught, teaching combinations, science loads and high school offerings. These data were obtained from Preliminary Annual Reports which are submitted by each high school in Virginia to the State Department of Education in the fall of each year.

Information also was obtained by an examination of the literature in the fields of general education, secondary education, science education, and teacher education.

Additional information was obtained

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through conferences with college science teachers, State school officials, superintendents, supervisors, principals, and high school science teachers. It was also secured through observation of college teachers, high school teachers, and students at both college and secondary school levels.

Findings and Observations

1. The investigation of certain aspects of science teaching in Virginia high schools through examination of the Preliminary Annual Reports to the State Department of Education revealed that more than 50 per cent of the high schools in Virginia have a minimum science offering of general science, biology, and chemistry each year. Notwithstanding this fact, more than 50 per cent of the teachers who taught one or more classes in science taught only one or two science classes. More than 60 per cent taught only one science subject and more than 85 per cent of the teachers taught no more than two classes in science. This is not a desirable situation for it appears that in general, teachers who are giving the major portion of their instructional time to other subjects will not do superior teaching in science. This is certainly true, if such teachers have had limited preparation in science.

More than 95 per cent of the high schools offer instruction in general science. More than 50 per cent of the science teachers in this study taught this subject. To teach general science effectively, one should have some competence in astronomy, biology, chemistry, geography, geology, meteorology, and physics. At the same time science teachers should be prepared to teach courses in biology, chemistry, geography, and physics.

Instruction in physics is not available to youth in 80 per cent of the high schools of Virginia. This is a very serious shortcoming in the light of the importance of physics in contemporary life. It also seems extremely unwise not to give more high school students who might be especially gifted in science an opportunity to explore the vocational possibilities associated with this field of knowledge. The institutions responsible for the education of teachers in Virginia should give careful consideration to this matter and formulate plans for the education of science teachers who are competent in the field of physics.

2. The information obtained from the study of Madison College graduates indicates that the pre-service education of prospective science teachers should be a very broad one insofar as study in the fields of science are concerned. They stated that prospective science teachers should receive the kind of preparation that would qualify them to teach general science, biology, chemistry, and physics.

The graduates further believed that instruction in most college science courses, for those preparing to teach science, should be organized around problems of everyday living. Were this done it seems that not only would abundant opportunities be given to master scientific knowledge, but if the problems studied were real live ones, it is likely that learnings would be more efficient since it is a generally recognized principle of learning that learning occurs best when there is a conscious motive or purpose for the activity. Moreover, if problems of current living were attacked in the college science courses, opportunities would be provided to learn to use the methods of scientists by practicing them—to learn scientific methods, not as abstract and abstruse procedures reserved for research laboratories, but as methods of thinking and doing that might operate in the solution of science problems within a social context. Furthermore, participation in such courses should help the students to take part effectively in policy-making.

It seems that students would have greater opportunities to learn the basic principles of science in a functional way, to develop understandings and appreciations of the important part scientists have played and are

playing in improving the quality of living, to acquire skills in improvising scientific equipment and in making the best use of the equipment at hand, to develop understandings of the normal experiences of everyday living, to develop understandings and appreciations of the requirements of good health, to acquire a broad and thorough knowledge of science, and to learn teaching techniques and procedures that would be of great value in teaching high school youth.

A majority of the graduates of Madison College, at several points in this study, expressed need for greater competence in social science. They believed that they should have received more help in making community studies and in learning ways to discover, analyze, and deal with social problems.

Majorities of the graduates thought that they should have had more work in college in student-teaching, in educational sociology, in guidance, and in courses in the teaching of the specific sciences. They felt that the courses in education, and psychology should be more practical, that more time should be given to the demonstration of good teaching methods—that instructors should demonstrate the effectiveness of their theories in their own teaching. A majority believed that student teaching could be improved by making it possible for each student-teacher to do her student teaching in the subject she expects to teach, by the provision of greater time for actual teaching and by providing opportunities for greater participation in the total program of the school.

A majority of the graduates believed that learning to live with people of diverse backgrounds, interests, and aspirations was one of the most valuable experiences that they had while at Madison College. Likewise, a majority of the graduates said that the personal interest shown by some members of the faculty and the individual attention and help given by them was one of the most valuable experiences which they had at Madison. It seems to the writer that the two foregoing observations have substantial implications for education.

A STUDY OF CERTAIN FACTORS INVOLVED IN CONSERVATION EDUCATION *

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For several weeks during the summer, the Michigan Department of Conservation offers an intensive indoctrination program for teachers at the Department's inservice training school at Higgins Lake. The groups of 40 to 70 participants from all parts of the state are sponsored through scholarships paid by local Garden Clubs or other civic organizations. These participants are mostly experienced teachers, with a sprinkling of school administrators and student-teachers. All size schools, all grade levels, and many subject specialties are represented in the groups although the elementary level predominates.

The staff people running the program have all had school teaching experience or a great deal of public relations work with the Michigan Schools.

The primary purpose of the program is to promote conservation teaching in the schools. The Conservation Department feels that this can be done by arousing in the participants an interest and understanding of the importance of natural-resource problems. The program is geared to instill this interest in teachers.

The Education Division of the Depart-

* Paper presented at Twenty-Sixth Annual Meeting of The National Association for Research in Science Teaching, Atlantic City, New Jersey, February 15, 1953.

ment sees conservation as a "state-of-mind" toward natural resources as well as a body of information on resources and resource-use techniques. The program stresses this "state-of-mind" viewpoint in all teaching, rather than a definite prescribed content or subject to be added to a curriculum. It is felt that teachers who have this attitude, with its concomitant perception of natural resources, will be motivated to transmit this conservation awareness at every appropriate opportunity that comes along. Integration in all work has higher priority than units, or subject areas aimed at conservation alone.

The Education Division stresses the belief that teachers can promote conservation starting with the "knowhow" they already have. All participants come to the program with some knowledge regarding resources, and it is the School's aim to provide a new framework into which these teachers can fit their personal knowledge. The School shows them how natural resources are part of a larger picture touching all human experience. On this base, if interest is present, the teacher can add new knowledge as it is gathered in the process of classroom teaching.

Implicit, then, in the Education Division's approach is the feeling: that conservation is, in part, a way of looking at Man's relationship to his natural resource environment; that teachers can incorporate conservation education into their school activities with the knowledge they already have, if they desire to do so; and that they will do this if they are interested, if they feel that it is important to do so. It implies that it is easy to start teaching conservation if the proper state of mind exists. If this attitude exists, teachers will transmit interest and awareness in their classroom and community activities.

With these premises, the program presents a broad view of natural resource conservation and its natural history and technological aspects, stressing relationships to man, the legal, political, economic, and other human factors that make up the total picture, all strongly flavored with historical development to cement the parts together.

This picture must be simply presented so that those new to the subject are not swamped, yet the experience must be meaty enough so that others with more knowledge remain interested on seeing familiar parts fitted to a new and larger whole.

For a year and a half a study of the Education Division's activities has been underway. This study of the conservation content and the presentation techniques employed by the Division is sponsored by the Education Division itself. The complete study is a doctoral problem in the Conservation Department of the School of Natural Resources, University of Michigan. It includes an examination and analysis of the following: (1) the conservation content and ideology presented in the Education Division's activities, (2) the administrative relationship of the Education Division to the Conservation Department and to other State departments such as the Department of Public Instruction, (3) the educational ideology and techniques used in their various programs, (4) the program techniques employed from a group process, or group dynamics standpoint.

The following material is selected from one area of this study and should be considered in relation to the larger study of which it is a part.

Since the primary objective of the Scholarship Program is to increase conservation teaching, a measure of the success of the program is the degree to which the participants are willing to say that they intend to increase their effort in this direction. This commitment to increase conservation teaching assumes an increased perception of the importance of the subject and an increased motivation to do something about it.

In observing the program's good and bad points, there was evidence that some participants did not see the same purposes for the sessions as did the staff, consequently

it seems questionable whether the expectations of these teachers would be fully met. To check this hypothesis, and using the assumption that commitment to increase effort in conservation teaching is a measure of increased motivation, a questionnaire was designed to get quantitative data on these points and on several questions related to other areas of the study. The schedule contained 64 opinion scales and 15 open-end questions, and was pre-tested on the first group. After refinement it was given to the remaining two groups on the last day of their session. The results of the 105 participants of these two groups are as follows:

On opinion scale questions

- 77% indicated that they intended to put a great deal more effort into their conservation teaching,
- 80% felt that they had learned a great deal,
- 80% felt that they were much more confident than before that they could improve their conservation teaching,
- 77% felt that the experience would help them a great deal in teaching their own subject areas,
- 90% saw the experience as adding greatly to their student's interest,
- 84% saw the experience as adding greatly to their own interest in teaching.

To the open-end question, "Do you think that teaching conservation will add more work to your teaching load?" Ten per cent said yes, but it was well worth it, and 80% felt there was no additional preparation work required.

Also of interest was the feeling of 80% of the participants, that their school administration was interested in their coming to the session.

With reference to their feeling toward filling out the questionnaire which took 30 to 50 minutes, 2% felt the questionnaire had no value, 9% were neutral, and 89% felt very willing to spend the time because it reviewed the week for them, or because they hoped it was of value to the program.

There is little doubt that the majority of the participants felt that they had gained a great deal from the experience.

What are the factors involved in this opinion of the experience, and which factors of the program seem important in leading toward commitment? What are the effects of expectation on enjoyment of the program and on willingness to make a commitment?

Current analysis of the data indicates the following: Willingness to make a commitment seems related to the degree to which participants recognize the importance of the session. However, if participants do not see their personal objectives being met, though they may see the importance of the purpose of the session, they are less likely to make a commitment than those whose personal objectives have been met. Participants who felt the program was of great importance, also felt that they learned a great deal, and felt more confident in their ability to improve their conservation teaching. If learning and confidence were felt to have been increased, there was a willingness to commitment.

Increased confidence appears related to more specific feeling toward the staff;

1—that they were very competent specialists in their own fields,
2—that they were excellent teachers,
3—that they made people enthusiastic.

Of 14 items of staff behavior, the first two choices as the most important were, "clarity of presentation," and "made people enthusiastic." Increased learning seems related to the general opinion that the staff was of very high quality. But those participants who did not see the program as fully meeting their expectations, even though they felt that the staff was excellent, did not feel that they had learned a great deal, and did not feel willing to make any commitments.

It appears that the Education Division's emphasis on an interest-creating program is effective in increasing attitude change. A majority of participants feel they have learned a great deal, and feel that they can and will do something in their own communities. This commitment is an evidence of the success of the program. The high percentage of participants who feel that conservation teaching adds little additional work to their own teaching, is a measure of the acceptance of the frame-of-mind viewpoint of conservation.

DEVELOPMENT OF A COURSE IN PHYSICAL SCIENCE FOR HIGH SCHOOL STUDENTS BASED ON THEIR EXPRESSED INTERESTS IN SCIENCE TOPICS *

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NEED FOR THIS STUDY. It is generally agreed by authorities that the leading subjects of the physical sciences do not attract a sufficient number of high school students, and that their content is not of maximum value in helping students solve their every day problems. This is true in spite of the rapid expansion of scientific information and its applications. Many reasons can be found in current literature for the existence of these unfavorable conditions.[1, 3] This study is an attempt to improve the situation by developing a course in physical science based largely on the expressed interests of high school students in science topics. The course is intended for juniors or seniors who may or may not go to college but who are not interested in science as a career.

Procedure. The following is a brief outline of the procedure carried out during the study:

1. An analysis of secondary school science textbooks in the fields of chemistry, physics, and sections of ninth grade general science (astronomy, geology, meteorology) for the purpose of determining the most common topics. This resulted in the assembling of four texts in each of the three areas.

2. Compilation of topics found in at least three of the four textbooks for each area. A topic as used in this study refers to the whole or half sentence, usually in bold type, that introduces a new idea.

3. Ranking of the topics by ten experienced and willing science instructors who were informed, through a conference, of the objective of this study. H. E. Garrett states that this is a reliable method for determining relative importance in item analysis.[2]

4. Formulation of a student questionnaire embodying 75% of the topics with the highest rank for each area. This resulted in 50 topics for general science, 60 topics for chemistry, and 100 topics for physics.

5. Administration of this form to 400 high school students in 20 different schools in Ohio. Only those students who had completed a course in chemistry were asked to check the chemistry form, etc. The topics were checked in terms of *Very Interested, Fairly Interested, Indifferent,* or *Not Interested.*

6. Assigning of rank to each topic.

7. Formulation of a Master Sheet, on percentage bases, regardless of subject matter area.

8. Organization of topics into broad units.

Results. Table I shows 10% of the topics for each of the three subjects that were ranked highest by the students in terms of their interests in them.

Table II shows 10% of the topics for each of the three subjects that were ranked lowest by the students in terms of their interests in them.

Proposed topical unit in physical science. After the formulation of a master list, the Herculean task was the construction of units that embodied the results of this study. It should be mentioned at this point that many details, essential to a comprehensive understanding of this research, have been left out in the interests of brevity.

As can be seen from Table III the topics comprising this unit are not necessarily

* Paper presented at Twenty-Sixth Annual Meeting of The National Association for Research in Science Teaching, Atlantic City, New Jersey, February 16, 1953.

TABLE I

UPPER 10% OF TOPICS AS RANKED BY STUDENTS

Subject	Rank	Topic No.	Description
Gen. Sc.	1	1	Origin of sun, planets, moon, stars
Chemistry	1	2	Principles of first aid
Physics	1	54	Repair of home electrical appliances
Gen. Sc.	2	32	Study of fossils
Chemistry	2	5	Properties of atmosphere, composition, etc.
Physics	2	74	Principles of photography
Gen. Sc.	3	44	Study of earthquakes
Chemistry	3	10	Principles of chemical and physical changes
Physics	3	3	Properties of three states of matter
Gen. Sc.	4	21	Causes of winds, cyclones, tornadoes, etc.
Chemistry	4	4	Molecular theory
Physics	4	68	Principles of atom smashers
Gen. Sc.	5	4	Composition of earth, inside and outside
Chemistry	5	26	Purification of water in own city.
Physics	5	67	Principles of atom and hydrogen bomb
Chemistry	6	9	Study of gases, properties, behavior, etc.
Physics	6	65	Study of lightning and thunder
Physics	7	38	Study of refrigeration and air conditioning
Physics	8	23	Study of water transportation, etc.
Physics	9	93	Principles of televising programs
Physics	10	95	Electrical safety

those with the highest rank. It is not advisable, as a matter of fact it is impossible, to force topics into units merely because of their high rank. An attempt has been made to develop units using topics with the best ranks. In no case were topics used that appeared in the lower 25% on the Master Sheet.

TABLE II

LOWER 10% OF TOPICS AS RANKED BY STUDENTS

Subject	Rank	Topic No.	Description
Gen. Sc.	46	31	Study of time belts or zones
Chemistry	55	50	Charles' law—volume and temperature
Physics	91	5	Study of simple and compound machines
Gen. Sc.	47	50	Astronomy in air and water transportation
Chemistry	56	34	Quantitative analysis
Physics	92	70	Properties of light—intensity, speed, etc.
Gen. Sc.	48	8	Characteristics of earth as magnet
Chemistry	57	60	Principles of titration and neutralization
Physics	93	99	Study of infrared, ultraviolet, X rays
Gen. Sc.	49	35	Principles of centrifugal, centripetal forces
Chemistry	58	58	Principles of hydroponics
Physics	94	100	Life history and works of famous scientists
Gen. Sc.	50	30	Study of latitude and longitude
Chemistry	59	52	Study of electromotive series
Physics	95	87	Study of common musical instruments
Chemistry	60	54	Avogrado's law—number of molecules in gases
Physics	96	71	Laws of reflection, refraction, difussion
Physics	97	66	Knowledge of electrical diagrams
Physics	98	98	Principles of electronic microscope
Physics	99	89	Principles of wave length
Physics	100	34	Study of latitude and longitude

TABLE III

PROPOSED UNIT 1 FOR PHYSICAL SCIENCE BASED ON STUDENT'S INTERESTS IN SCIENCE TOPICS

Subject	Rank	Topic. No.	Description
Physics	3	3	Properties of three states of matter
Chemistry	4	4	Molecular theory
Chemistry	6	9	Study of gases, properties, behavior, etc.
Chemistry	3	10	Principles of chemical, physical changes
Chemistry	2	5	Study of atmosphere, composition, work, etc.
Chemistry	15.5	8	Kinetic theory of gases
Gen. Sc.	1	1	Origin of sun, earth, planets, etc.
Gen. Sc.	5	4	Composition of earth, inside and outside
Chemistry	15.5	7	Principles of temperature and thermometers
Physics	11	36	Principles of expansion and contraction
Gen. Sc.	13	36	Nature of volcanoes
Gen. Sc.	17	33	Formation of coal, oil, gases
Gen. Sc.	15	39	Making of oceans, seas, lakes, rivers, etc.

Conclusions. As a result of this study the following conclusions can be made:

1. Students expressed great interest in current science topics such as radioactivity, interplanetary travel, atomic energy, etc. In most cases these are studied at the end of the school year if time permits.

2. Many laws and basic principles were ranked low. This need not necessarily indicate the elimination of such content from the curriculum but rather a more functional presentation of them.

3. Functional topics such as home wiring, photography, and removal of stains were ranked high.

4. Subject matter which students understood better because of repetition—molecular theory, study of the atmosphere, properties of gases, etc.—was given a high rank. This would seem to indicate that repetition which results in better understanding need not be boring.

5. Mathematical concepts were ranked low with the exception of the metric system.

REFERENCES

1. Federal Security Agency. "Offerings and Enrolments in High School Subjects", Washington, D. C., U. S. Office of Education, 1948–1949.
2. Garrett, H. E. Statistics in Psychology and Education. New York, Longman's, Green and Company 1947.
3. Laton, A. D. and Powers, S. R. New Directions in Science Teaching. New York, McGraw-Hill Book Company, 1949.

A REPORT TO THE *NARST* ON THE ACTIVITIES FOR 1952–53 OF THE COOPERATIVE COMMITTEE ON THE TEACHING OF SCIENCE AND MATHEMATICS OF THE AAAS *

GEORGE GREISEN MALLINSON
Western Michigan College of Education, Kalamazoo, Michigan

At the last three meetings of the NARST, the representative on the Cooperative Committee has presented his report in two sections, (1) a brief verbal summary of the more important activities for the year, and (2) a brochure for each member of the NARST attending the convention, that contains copies of the minutes and publications of the Cooperative Committee for the past year. The same procedure will be followed for this year.

* Report of the NARST representative on the Cooperative Committee made at Twenty-Sixth Annual Meeting of The National Association for Research in Science Teaching, Atlantic City, New Jersey, February 17, 1953.

PERSONNEL OF THE COOPERATIVE COMMITTEE

The personnel of the Cooperative Com-

mittee remained relatively stable during the year, although two changes were made. A list of the members of the Cooperative Committee follows. The names marked with an asterisk (*) are those of the new representatives:

1. American Association of Physics Teachers
   Dr. Bernard B. Watson, Secretary
   Defense Manpower Administration
   U. S. Department of Labor
   Washington, D. C.
2. American Astronomical Society
   Dr. Thornton Page
   Johns Hopkins University
   Baltimore, Maryland
3. American Chemical Society
   Dr. C. H. Sorum
   Department of Chemistry
   University of Wisconsin
   Madison, Wisconsin
4. American Geological Institute
   Dr. Arthur L. Howland
   Department of Geology
   Northwestern University
   Evanston, Illinois
5. American Institute of Physics
   Dr. J. W. Buchta
   Department of Physics
   University of Minnesota
   Minneapolis, Minnesota
6. American Nature Study Society
   Dr. Richard L. Weaver
   School of Natural Resources
   University of Michigan
   Ann Arbor, Michigan
7. American Society for Engineering Education *
   Professor Milton O. Schmidt
   College of Engineering
   University of Illinois
   Urbana, Illinois
8. American Society of Zoologists
   Dr. L. V. Domm
   Hull Anatomical Laboratory
   University of Chicago
   Chicago, Illinois
9. Botanical Society of America
   Dr. Glenn W. Blaydes
   Department of Botany
   Ohio State University
   Columbus, Ohio
10. Central Association of Science and Mathematics Teachers
    Mr. Donald W. Lentz, Principal
    Ridge Road School
    6726 Ridge Road
    Parma 29, Ohio
11. Division of Chemical Education of the American Chemical Society
    Dr. Laurence L. Quill
    Department of Chemistry
    Michigan State College
    East Lansing, Michigan
12. Executive Committee of the American Association for the Advancement of Science
    Dr. Duane Roller *
13. Mathematical Association of America
    Dr. J. R. Mayor
    Departments of Mathematics and Education
    University of Wisconsin
    Madison 6, Wisconsin
14. National Association of Biology Teachers
    Mr. Prevo L. Whitaker
    University School
    Indiana University
    Bloomington, Indiana
15. National Association for Research in Science Teaching
    Dr. George G. Mallinson
    Professor of Psychology and Education
    Western Michigan College of Education
    Kalamazoo, Michigan
16. National Council of Teachers of Mathematics
    Mr. George H. Hawkins
    Lyons Township High School and Junior College
    La Grange, Illinois
17. National Science Teachers Association
    Dr. Morris Meister, Chairman
    Principal, High School of Science
    120 East 184th Street
    New York 68, New York
18. Section Q (Education) of the American Association for the Advancement of Science
    Dr. Francis D. Curtis
    School of Education
    University of Michigan
    Ann Arbor, Michigan

THEME FOR THE YEAR

During the year the Cooperative Committee met or participated in conventions on three separate occasions. The first activity was held at the University of Wisconsin on May 4 and 5, 1952; the second, in conjunction with the Manpower Conference of the U. S. Office of Education on November 14, 15 and 16 in Washington, D. C.; and the third, at the convention of the American Association for the Advancement of Science, St. Louis, Missouri, December 26–31.

At all these meetings much of the time was spent in exploring the problems related to the identification and training of persons talented in the fields of science and mathematics. The great amount of time spent this last year is likely to result in eliminating this area from further delibera-

tions of the committee, at least in the near future.

The major theme under consideration last year, namely, the shortage of scientists and engineers is no longer a subject of major deliberation on the part of the committee. The shortage has received great consideration from many sources and is now less alarming than it was a year ago. It is hoped that the solution of the problem of identifying and training of scientific talent at the pre-college level has been aided by the deliberations of the Cooperative Committee.

The rest of this report will deal with the major activities and interpretations of conclusions made at each of these meetings.

THE MEETING IN MADISON, WISCONSIN MAY 3 AND 4, 1952

A number of routine items and activities were cared for and reports given by members of sub-committees. The only item of major import of routine business was the possibility of the Cooperative Committee sponsoring certain types of publications for influencing high-caliber students to enter careers in science and mathematics. Subcommittees were established to investigate various types of possible publications.

The major portion of the Madison meeting was devoted to a discussion of various activities in progress throughout the United States in projects for the education of youth with high-level talent in science and mathematics. Reports were made on the progress of the Ford Foundation Scholars who were at the various universities in the United States. Dr. Howe who has charge of such students at Wisconsin reported on the success of the program there. In general, it was indicated that these students who entered college prior to graduation from high school had no serious educational or disciplinary problems and were succeeding apparently as well as if they had spent four years in high school.

Another report was made concerning possibilities of a grant-in-aid from the Ford Foundation for a major study involving "An Investigation of the Effectiveness of Early Identification and Training of Youth of High Promise, Including Especially Those With High Potential in Science and Mathematics." The committee decided that while it might be interested in endorsing such a project, if the plans were developed in greater detail and were in harmony with the policies of the committee, it was not seeking the responsibility for administering it.

A relatively lengthy discussion was held concerning the endorsement by the Cooperative Committee of a proposal submitted by the National Science Teachers Association for the establishment of a Future Scientists of America Foundation. Such a foundation, operated by the Board of Directors of the NSTA, would in theory stimulate and sponsor research projects in the field of science teaching, science teacher recognition awards, institutes and workshops, science student awards and a national organization of science student clubs known as the "Future Scientists of America."

The committee approved the general objectives of such an overall plan, but expressed the view that such a foundation would participate in a number of activities already carried on by other organizations. Hence it was agreed that the relationship between such organizations and the proposed foundation be thoroughly studied before any endorsement was made.

The controversy between scientists and educators inspired by Professor Harry J. Fuller in his article, "The Emperor's New Clothes" in the January issue of *Scientific Monthly,* together with a letter from Professor Cairns, head of the Department of Mathematics at the University of Illinois, attacking the teaching of mathematics in high school was discussed. The committee felt that its role was two-fold:

1. To take what action possible to bring the factions together for a rational discussion of the differences.

2. To prepare a statement of the attitude of the committee toward the controversy for publication in *Science*. This task was delegated to Drs. Curtis and Mayor.

A copy of a letter from the Cooperative Committee to John Steelman, Acting Director of the Office of Defense Mobilization is enclosed with the minutes. It is self-explanatory and concerns certain views of the committee toward the use of scientific personnel.

THE MEETING IN WASHINGTON, D. C. NOVEMBER 14, 15 AND 16, 1952

The Washington meeting was held in two different sections. The first was held in conjunction with a Manpower Conference of the U. S. Office of Education. The members of the Cooperative Committee acted as reporters for the group sessions held concerning the identification, training, and use of youth with scientific talent. In general, as summarized by Dr. Johnson and Dr. Brown of the U. S. Office of Education, the following conclusions were reached:

1. Talent in science and mathematics probably consists of a complex of differential aptitudes, or primary mental abilities, all these being of a relatively high-level in a youth of high talent. Such a complex might consist of high-level differential aptitudes in the quantitative, spatial relationships, and verbal areas.

2. In the average public school there is probably a lack of time, training and facilities for successful identification of talent on the bases just mentioned. Hence talent in science and mathematics will have to be identified on more general characteristics, namely a high-level general ability marked especially by quantitative ability and expressed interest in science.

3. That any means for fostering such talent will depend greatly on school facilities. However, it was felt that the major problem of fostering the use of talent, rested not with the development of new educational procedures, but rather with the use of what already has proven to be effective.

Through arrangements with the U. S. Office of Education, a copy of the report of the Manpower Conference will be sent each member of the NARST.

The second section was devoted to deliberations involving affairs of the Cooperative Committee itself. At this meeting it was decided to continue with the affiliation at the AAAS meetings with the other science teaching societies.

Much of the remaining time was spent on topics that concerned directly or indirectly the exploitation of science talent. Meister reported further on the possibilities of Ford Foundation grants. He indicated however that the proposed program for a study involving the identification of science talent and discussed by the Cooperative Committee at the previous meeting was not in the general pattern of the studies sponsored by the Ford Foundation. Hence it would probably be unacceptable to the officers of the foundation. The Ford Foundation apparently is interested only in sponsoring those studies that will produce educational changes with which they are in favor.

The proposed program for publications received essentially negative reports. It was felt that the shortage of published guidance materials for science and mathematics had changed greatly since the last deliberations of the committee. A number of organizations had since then published materials for the purpose mentioned and these materials were of high quality.

The controversy between scientists and educators was again discussed thoroughly. The article prepared by Curtis and Mayor and which appeared in the July 25, 1952 issue of *Science* was then discussed. Two further suggestions were then made:

1. That the Cooperative Committee explore possibilities for a joint meeting with school administrators concerning the Fuller controversy.

2. That the Cooperative Committee reorient itself to teaching conditions in the

public schools by inviting administrators to participate in the next meeting of the Cooperative Committee.

The latter suggestion was accepted tacitly in that plans were tentatively made for the Spring meeting to be concerned with certain ramifications of the suggestion, and also that the Cooperative Committee might sponsor a symposium in this area at the AAAS convention in Boston in December 1953. Your representative is more than gratified at such possibilities since it is probable that an examination of "grassroots" situations in science and mathematics teaching may well keep the committee's activities in proper perspective.

Emerging from this general discussion also was a motion approved that a subcommittee be appointed to recommend action to be taken in the Fuller controversy. Two further major actions were taken:

1. Dr. Meister was elected to continue as Chairman for one year and Dr. Watson as Secretary for the same period.

2. The committee accepted the invitation of Western Michigan College of Education to meet on its campus for the spring conference in 1953. The dates were tentatively set for May 15, 16 and 17.

THE MEETING AT THE AAAS CONVENTION IN ST. LOUIS, DECEMBER 26–31, 1952

On Sunday, December 28 at 1:30 p.m. in the Hunt Room, Hotel DeSoto, St. Louis, Missouri, the Cooperative Committee sponsored a symposium entitled *Identification of Talented Youth in Science and Mathematics.* The meeting was co-sponsored by the NABT, NSTA and ANSS.

The Cooperative Committee also co-sponsored all the general meetings of the joint science teaching societies affiliated with the AAAS as well as one meeting of Section Q.

At the convention plans were discussed for the meeting in Boston in December 1953. The representatives of the joint science teaching societies will meet in the late winter in Indianapolis to discuss plans. Professor Prevo Whitaker has been appointed overall coordinator of the Boston sessions.

PROGRAM
of the
TWENTY-SIXTH ANNUAL CONVENTION
of
THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

February 14–17, 1953

Chalfonte-Haddon Hall
Atlantic City, New Jersey

Officers of the

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

President

Dr. J. Darrell Barnard
School of Education
New York University
New York, New York

Vice-President

Dr. George G. Mallinson
Departments of Psychology and Education
Western Michigan College of Education
Kalamazoo, Michigan

Secretary-Treasurer

Dr. Clarence M. Pruitt
304 Walnut Street
Stillwater, Oklahoma

Executive Committee

Dr. Kenneth E. Anderson
School of Education
University of Kansas
Lawrence, Kansas

Dr. Betty Lockwood Wheeler
Maple Hill—Route 3
Mt. Pleasant, Michigan

SATURDAY, FEBRUARY 14, 1953

8:00 P.M.—Meeting of Executive Committee

Room 1332 Haddon

SUNDAY, FEBRUARY 15, 1953

Navajo Room—Chalfonte-Haddon Hall

PROGRAM FOR GRADUATE STUDENTS

George Greisen Mallinson—*Chairman*

I. Progress Reports and Discussions of Research of Graduate Students in Science Education

9:00–9:30 A.M.—Registration and Get-Acquainted

9:30–10:00 A.M.—"A Study of the Manner in Which A Group of Ninth-Grade General Science Students Analyze Selected Problems." Mrs. Edith G. Chess, New York University.

10:00–10:30 A.M.—"A Study of Certain Factors Involved in Conservation Education." Gilbert Banner, University of Michigan.

15-Minute Intermission

10:45–11:15 A.M.—"A Study of A Young Child's Interaction With The Physical Phenomena of His Environment." John G. Navarra, Teachers College, Columbia University.

11:15–11:45 A.M.—"An Investigation of Teacher Recognized Difficulties Encountered in the Teaching of Science in the Elementary Schools of Florida and Michigan." Albert Piltz, University of Florida.

DISCUSSION

Lunch

II. Carrying Out and Reporting Research

2:00–2:30 P.M.—"Designing A Research Study in Science Education." Dr. Ellsworth S. Obourn, John Burroughs School, Clayton, Missouri.

2:30–3:00 P.M.—"Selecting Statistical Techniques in A Research Study." Dr. Kenneth E. Anderson, Dean, School of Education, University of Kansas, Lawrence, Kansas.

3:00–3:30 P.M.—"Methods of Writing and Reporting A Research Study." Dr. Francis D. Curtis, Professor of Education and of the Teaching of Science, University of Michigan.

3:30–4:00 P.M.—Discussion

Informal Get-Together

6:30 P.M.—Annual Banquet, Sunday, February 15, 1953, Mandarin Room, Chalfonte-Haddon Hall.

Speaker: Lt. Colonel D. H. Heaton, Acting Director of Aeronautics and Propulsion, office, Deputy for Development, Headquarters, Air Research and Development Command, United States Air Force.

Topic: "Some Problems Involved In Jet Propulsion."

MONDAY, FEBRUARY 16, 1953

Navajo Room—Chalfonte-Haddon Hall

REPORTS OF RESEARCH

Kenneth E. Anderson, *Chairman*

9:00–9:30 A.M.—"Some Implications and Practical Applications of Recent Research in the Teaching of Science at the Secondary-School Level (1948–53)." George G. Mallinson, Western Michigan College of Education, Kalamazoo, Michigan.

9:30–9:50 A.M.—"Some Implications and Practical Applications of Recent Research in the Teaching of Science at the Elementary School Level (1929–53)." Jacqueline V. Buck, Farmington High School, Farmington, Michigan.

9:50–10:10 A.M.—"Some Implications of Errors in Scoring Science Examinations and the Effect of Such Errors on Student Achievement." Kenneth H. Summerer, Grand Blanc Township High School, Grand Blanc, Michigan.

10:10–10:30 A.M.—"Recent Trends in High School Science Enrollments." Philip G. Johnson, Specialist for Science, Secondary School Section, Federal Security Agency, Office of Education, Washington 25, D. C.

10:30–10:50 A.M.—"Applying Biology to the Physical Sciences." Nathan S. Washton, Queens College, Flushing, New York.

10:50–11:10 A.M.—"The Education of Science Teachers at Madison College." Percy H. Warren, Madison College, Harrisonburg, Virginia.

11:10–11:30 A.M.—"A Determination, Analysis, and Evaluation of Representative Assumptions With A Group of Selected Experimental Exercises in Ninth-Grade General Science, and A Study of How Teachers Make Provision for These Assumptions in Their Teaching." Ellsworth S. Obourn, John Burroughs School, St. Louis, Missouri.

11:30–11:50 A.M.—"The First National Aviation Education Workshop Jointly Sponsored by the University of Colorado and Civil Air Patrol, July 24–August 27, 1952." Stanley B. Brown, University of Colorado, Boulder, Colorado.

LUNCH

REPORTS OF RESEARCH

J. Darrell Barnard, *Chairman*

2:00–2:15 P.M.—"Development of a Course in Physical Sciences for High School Students Based on Their Interest." Steven J. Mark, Kent State University, Kent, Ohio.

2:15–2:30 P.M.—"Factors of Effectiveness in Science Teaching and Their Application to the Teaching of Science in Ohio's Public Secondary Schools." Warren Maywood Davis, Alliance Public Schools, Alliance, Ohio.

2:30–2:50 P.M.—"Some Problems of Student-Teaching and Teacher-Education in New York City." Jerome Metzner, Jamaica High School, Jamaica, New York.

2:50–3:10 P.M.—"Innovations at Wayne University in College Science Courses for General Education." Vaden W. Miles, Wayne University, Detroit, Michigan.

3:10–3:30 P.M.—"Imperatives from Experimental Philosophy for Teaching Natural Science in College General Education Programs." John N. Moore, Michigan State College, East Lansing, Michigan.

3:30–3:50 P.M.—"Educational Implications of Studies on Mental Rigidity to the Teaching of the Scientific Method." Marvin D. Solomon, Michigan State College, East Lansing, Michigan.

3:50–4:10 P.M.—"A Synthesis and Evaluation of Objectives for a Freshman Course in College Biology." Mary Alice Burmester and Victor H. Noll, Michigan State College, East Lansing, Michigan.

4:10–4:30 P.M.—"The Selection and Grade Placement of Physical Science Principles in the Elementary School Curriculum." Renato E. Leonelli, Rhode Island College of Education, Providence, Rhode Island.

Tuesday, February 17, 1953

Navajo Room—Chalfonte-Haddon Hall

REPORTS OF RESEARCH

Thomas P. Fraser, *Chairman*

8:40–9:00 A.M.—"A Study of Opinions Regarding the Place of Science in Society." Leland L. Wilson, Georgia Teachers College, Collegeboro, Georgia.

9:00–9:20 A.M.—"Evaluation of Science in General Education at the College Level." W. C. Van Deventer, Stephens College, Columbia, Missouri.

9:20–9:40 A.M.—"The Student in Medical and Health Education." A. W. Hurd, Medical College of Virginia, Richmond, Virginia.

9.40–10:00 A.M.—"Test Items and Curriculum Background As Factors Which Influence Results in Evaluating Learning in High-School General Science." William B. Reiner, New York City Board of Education, Brooklyn, New York.

10:10–10:30 A.M.—"A Comparative Study of Sixth-Grade Pupils' Science Achievement in Schools Having Contrasting Science Curriculums." Donald A. Boyer, Winnetka Public Schools, Winnetka, Illinois.

10:30–11:30 A.M.—Reports of Special Committees.

11:30–12:30—Business Meeting.

OFFICIAL MINUTES OF THE BUSINESS MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

Chalfonte-Haddon Hall, Atlantic City, New Jersey February 17, 1953

President J. Darrell Barnard presided at the annual business meeting of the National Association for Research in Science Teaching in the Navajo Room, Chalfonte-Haddon Hall, February 17, 1953. The official minutes of the last business meeting held at Chicago, Illinois, February, 16, 1952, and published in the February, 1953, issue of *Science Education* were approved as published.

The report of the Auditing Committee of the Treasurer's book was made for the committee by Archer W. Hurd, Chairman. Other members of the Committee were Benjamin C. Gruenberg and George C. Wood. The chairman reported the Treasurer's book had been audited and found to be in balance. The report was accepted. Treasurer Clarence M. Pruitt then read the report as it is published in this issue of *Science Education*. It was moved and seconded that the Treasurer's report be accepted. The motion carried.

The report of the Nominating Committee was made by N. Eldred Bingham, Chairman. Other members of the Committee were Francis D. Curtis and Donald A. Boyer. The Nominating Committee presented the following slate of officers for 1953–54:

President:	GEORGE GREISEN MALLINSON
Vice-President:	KENNETH E. ANDERSON
Secretary-Treasurer:	CLARENCE M. PRUITT
Executive Committee:	J. DARRELL BARNARD WILLIAM C. VANDEVENTER

Nominations from the floor were called for. It was moved and seconded that the report of the Nominating Committee be accepted and that the Secretary be empowered to cast a unanimous ballot for those named by the Nominating Committee. The motion carried.

Discussion was then held as to the meeting place for 1954. The Secretary reported that in the recent mail vote ballot by members resulted in the following first choice preferences:

Washington	27	St. Louis	5
Chicago	27	Buffalo	4
New York	21	Milwaukee	3
Detroit	12	Toronto	25
Indianapolis	9	Miami	26
Cleveland	9	Denver	23
Cincinnati	7	San Francisco	14
Minneapolis	5		

It was announced that the AASA had decided to meet two years in Atlantic City followed by regional meetings and that the AASA would meet in Atlantic City in 1954. It was finally decided to leave the 1954 meeting place up to the Executive committee based on a second mail vote by members with two possible meeting places for 1954, with three different dates involved. The Secretary was asked to list the advantages of each of the three possible dates in the ballot to be sent out to members. It was suggested that Executive Committee consider the possibility of closer relationships with the National Science Teachers Association, the National Council for Elementary Science, and other similar organizations.

The Secretary called the attention of members to the passing of four members of the National Association for Research in Science Teaching during 1953, namely: Walter G. Whitman, Ward T. Fletcher, Vernon S. Culp, and Cecil F. DeLaBarre. It was moved, seconded, and carried that the Secretary convey to the wives and families of the four members the sympathy of the organization on the loss of these members.

The following members having reached the age of retirement were voted into Life Membership in NARST: Clarence E. Baer, Earl R. Glenn, John E. Jensen, Charles E. Montgomery, Charles J. Pieper, E. Laurence Palmer, S. Ralph Powers, and F. A. Riedel.

It was announced that all proposed new members had been elected by vote of members and had been declared duly elected by the Executive Committee. (See list published elsewhere in *Science Education*).

Anderson made a report for F. A. Riedel, Acting Chairman of the Junior-Senior High School Committee. It was suggested that Dr. Philip G. Johnson of the U. S. Office of Education send out forms to institutions of higher education to secure lists of research studies as he has been doing in the past and that he be supplied with 1000 copies of the Curtis Committee Report on Research published in the February, 1953, *Science Education*. There was much discussion of the need and desirability for the publication and making available the research and investigations being made each year relating to the teaching of science.

As a result of the discussion and with the assurances of cooperation from Dr. Philip G. Johnson it was decided that the NARST should begin a series of annual reviews of science education research to replace the issue being dropped by the AERA. In general, the plan was to use the abstracts of research sent to, and made available by, Dr. Johnson and to combine these findings with the findings of published research not reported by Dr. Johnson. The level committees would prepare the written reviews for publication in *Science Education*.

It was moved and seconded and passed that Dr. Kenneth E. Anderson be appointed to supervise the preparation of the reviews and to make whatever arrangements are

necessary with Dr. Johnson and the Office of Education.

There is need for more careful screening of prospective members of NARST and the Executive Committee was asked to consider means of doing this. The Executive Committee was also asked to explore the possibilities of Associate members.

It was recommended by the Executive Committee that annual dues of NARST be changed to $7.00 of which $5.00 would go to *Science Education*. Reasons given for this change were the present inadequate financing of both NARST and *Science Education*. NARST dues had remained at $5.00 since before the days of the depression. Some members suggested that even the $7.00 may be inadequate. After brief discussion, it was moved and seconded that the annual dues be raised to $7.00, of which $5.00 is to go to *Science Education*. The motion carried.

It was moved and seconded that the Secretary be empowered to write letters to members in foreign countries to the effect that they were very much missed when they could not attend the annual meeting. Motion carried.

It was moved and seconded that the 1952 officers of NARST and others responsible for the success of the meeting be extended a vote of thanks by the Association. Motion carried.

A motion was made, seconded, and carried, that the 1953 business meeting be declared adjourned.

Executive Committee Meeting
February 14, 1953
Room 1332, Haddon Hall

Members present were Barnard, Mallinson, Pruitt, and Anderson.

Rooms for the meetings of the various committees on Monday night were assigned.

The Secretary reported the results of the voting for the 1954 meeting of NARST. It was decided to have the matter of the meeting place discussed at the business meeting. The Secretary also reported the vote on the proposed new members. Five of the new members received no negative votes. The highest number of votes cast for any one member was 117. The Executive Committee declared all proposed new members duly elected and to so announce at the business meeting. Attention was also called to the recent deaths of four members.

Considerable discussion was had concerning the need for increasing annual dues from the present $5.00. This rate had been in effect since the early thirties—even before the depression. To effectively finance the activities of NARST and to more adequately support the official publication, *Science Education*, it was agreed that annual dues should be increased. Originally NARST had assumed to approximately finance the cost of publication of NARST materials in *Science Education*. For many years, NARST has not approximated this support—not even paying for the cost of one issue of *Science Education*. During the present year, NARST material filled nearly four issues of the magazine. It was decided that the Executive Committee would recommend to the members at the business meeting that the dues be increased to $7.00 annually of which $5.00 should go to *Science Education*.

The Executive Committee with regret accepted the resignations of certain individuals from NARST membership. (See list elsewhere in this issue).

Procedures for the Banquet and Business meeting were discussed. Meeting adjourned.

Executive Committee Meeting
February 17, 1953

Members present: Mallinson, Anderson, Pruitt, Barnard, and Van Deventer.

The Secretary will poll members as to their preference for 1954 meeting.

Anderson was appointed to head the Committee to work with Dr. Philip G. Johnson of the U. S. Office of Education.

The Executive Committee authorized the sending of 1000 reprints of the Curtis Re-

search Committee Report to Dr. Philip G. Johnson.

Anderson and Barnard were appointed to plan that part of the 1954 program having to do with research papers. VanDeventer is to plan the Dinner meeting and afternoon program. Mallinson will arrange for the Graduate Student program and the morning meeting. Meeting adjourned.

DINNER MEETING

There were forty-seven members and guests present at the Dinner meeting. Members attending were: Benjamin C. Gruenberg, George C. Wood, J. Darrell Barnard, George G. Mallinson, Kenneth E. Anderson, Philip G. Johnson, Morris Meister, Stanley B. Brown, Gordon M. Dunning, Marvin D. Solomon, Vaden W. Miles, John N. Moore, Charles W. Hoffman, Thomas P. Fraser, Hubert M. Evans, Nathan A. Neal, William B. Reiner, Charles W. Reynolds, Ellsworth S. Obourn, N. Eldred Bingham, James C. Adell, Donald A. Boyer, M. L. Robertson, Willard Jacobson, W. W. E. Blanchet, Francis D. Curtis, W. W. Rasor, Wm. C. VanDeventer, Malvina Trussell, F. A. Riedel, and Clarence M. Pruitt.

Respectfully submitted,
CLARENCE M. PRUITT
Secretary, NARST

RESIGNATIONS FROM MEMBERSHIP IN NARST

H. J. Edwards Ahrens, Long Beach, California; Charles A. Browning, Knoxville, Tennessee; Mildred Einzig, Cleveland, Ohio; Warren P. Everote, Wilmette, Illinois; Edward Z. Friedenberg, Chicago, Illinois; James Harlow, Norman, Oklahoma; Jack Hudspeth, Austin, Texas; Warren W. McSpadden, New York, New York; Arthur L. Mills, Lake Geneva, Wisconsin; Shailer A. Peterson, Chicago, Illinois; Thomas C. Polson, Berkeley, California; Frederick A. Rantz, Seattle, Washington; William Hugh Stickler, Tallahassee, Florida; Zachariah Subarsky, Bronx, New York; Wenonah Sullivan, Seattle, Washington; Hugh Templeton, Albany, New York.

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

FINANCIAL REPORT FEBRUARY 17, 1953

RECEIPTS

Balance on Deposit	$ 759.07
Membership Fees	940.00
Total	$1699.07

EXPENDITURES

Printing Silver Anniversary Brochures and Programs	$ 150.00
National Conference for Cooperative Health Education dues	15.00
Oscar and Associates Picture Setting	30.00
Charter Members Dinners	54.60
Bank Charges	3.00
Secretary Expense	65.00
J. Darrell Barnard Expense	6.07
Kenneth E. Anderson Expense	13.00
Mallinson Expenses as Cooperative Representative	74.70
Mallinson Expenses (Chicago Mixer, stationary, printing, mailing)	115.11
Lt. Colonel D. H. Heaton—Atlantic City	50.00
Science Education Subscriptions	820.00
Total	$1396.48

BALANCE

Receipts	$1699.07
Expenditures	$1396.48
Balance on Deposit	$ 302.59

Respectfully submitted,
CLARENCE M. PRUITT
Treasurer—NARST.

BOOK REVIEWS

KILANDER, H. F. *Kilander Health Knowledge Test.* Yonkers, New York: World Book Company, 1951. Specimen Set $0.35.

This is one of the World Book *Evaluation and Adjustment Series* of high school tests. The *Anderson Chemistry Test, Dunning Physics Test, Read General Science Test,* and *Nelson Biology Test* have been reviewed previously in Science Education. All tests were constructed and validated according to rigid standards. Item content was carefully selected so as to measure certain outcomes that seem desirable in teaching health. Corrected split-half reliability coefficients of .88 and .86 were obtained. There are 75 multiple-choice items. Norms are given for the test. The specimen set includes a copy of the test, a manual of directions, class record, key, and answer sheet.

KILANDER, H. F. *Health Services in City Schools.* Washington, D. C.: United States Government Printing Office, Superintendent of Documents, 1952. 68 p. $0.25.

This report should be of special interest to biology, general science, and health teachers, to public health officials, school administrators, parent-teacher associations, and all laymen having an interest in the school health program. The study was undertaken in cooperation with the Public Health Services of the Federal Security Agency and the American Medical Association under the direction of Dr. Kilander. It shows the present status of many phases of health services in 91 per cent of the cities having a population of 2,500 or more.

The report has 31 tables summarizing the results of the study. A number of trends is evident from a study of the information gathered.

KILANDER, H. F. *Health Instruction in the Secondary Schools.* Washington, D. C. Superintendent of Documents, U. S. Government Printing Office, 1952. 20 p. $0.10.

This pamphlet is based on a cooperatively conducted study by the American School Health Association and the U. S. Office of Education. A questionnaire developed by the Committee on Health Education in the Secondary Schools of the American Health Association was sent to each of State departments of education. The data presented give the present status of health instruction in the secondary schools. The questionnaire was returned by 33 State Directors of Health and Physical Education or of Health Education. 8 Supervisors of Secondary Education and 7 other members of State Departments of Education.

The pamphlet discusses state regulations concerning health instruction in secondary education, responsibility for health education standards, credit for health education, amount of time and credit given to health instruction, correlating health instruction with other subjects, and requirements for health teaching.

Some of the findings were: (1) Thirty-three states require health education as a required subject in the secondary schools—27 by state law and 6 by regulations of the State departments of education. Half of these states are included in the 30 states which have special legislation requiring the teaching of alcohol and narcotics; (2) Twenty-five states have health education as a required subject in the curriculum; (3) Twenty-three states report courses of study in health education for secondary schools; (4) Forty-four states report that credit in health instructions is counted toward graduation—usually limited to one unit of the sixteen ordinarily required for graduation; (5) The plan recommended most frequently by state departments of education and by national organizations is that of daily class periods for one or two semesters; (6) Twelve states indicate that a combination major in health and physical education is required for teachers who are to teach health. Most states report that physical education and health education are taught by the same certified teacher. Science teachers, home economics teachers, and school nurses are also reported as teaching health classes.

BEUSCHLEIN, MURIEL. Free and Inexpensive Materials for Conservation Education. Ann Arbor, Michigan. (P. O. Box 2073): Dr. Richard L. Weaver, 1953. 15 p. $0.10.

This pamphlet is a contribution of the Conservation Project of The National Association of Biology Teachers. The Conservation Project was directed by Dr. Richard L. Weaver, Conservation Department of the University of Michigan and executed by state chairmen and committees in each state.

It was underwritten by a grant-in-aid from The American Nature Association, to develop materials to assist biology teachers in more effective conservation teaching.

Materials are listed alphabetically by states with the source and address. A brief description of the material is often included. It was not possible to evaluate most of the material.

Conservation, biology, general science, and elementary science teachers should find this an excellent resource publication.

BREWSTER, PAUL G. *American Nonsinging Games.* Norman, Oklahoma: University of Oklahoma Press, 1953. 219 p. $3.75.

Play is perhaps the most universal social activity, and games are among the oldest recorded institutions of man. Blind Man's Buff was current in the time of Christ. Odd or Even comes to us from Greek and Roman times and was mentioned by Horace, Aristotle, and Ovid.

American Nonsinging Games presents more than 150 of the better known games, drawn from every state in the Union. Games are the common possession of all of us and a true part of the American tradition. Each game is clearly and simply described, in many cases with diagrams. Following the description there is interesting information about the origin of the game, where and how it is played in other lands, and how long it has been played there. Games are listed under Guessing Games, Forfeit Games, Chasing Games, Ball Games, Elimination Games, Jumping and Hopping Games, Practical Jokes, Paper and Pencil Games, Stick Games, Games of Little Girls, and Miscellaneous Games. There is a well-selected bibliography and an index.

Elementary teachers and recreation leaders will find this the best source of American Nonsinging games that has been published. Children will love many of the games that they have never seen or heard about. Teachers will find no difficulty in introducing them.

ADAMS, FAY, GRAY, LILLIAN, AND REESE, DORA. *Teaching Children to Read.* New York: The Ronald Press Company. 525 p. $4.50.

Seemingly more stress is now being made on reading than was the case five or ten years ago. Parents and the public, as well as a great many teachers, are demanding that pupils in the grades should attain certain desirable essentials in reading skills. On the other hand there are many individuals who insist the schools are now doing the best job of teaching reading they have ever done and the numbers of below standard, ineffective readers, are relatively low when one considers the great mass of pupils now enrolled in elementary schools.

Most teachers and parents admit reading is a most necessary and effective tool in making educational progress. All teachers are interested in making their work more effective and reading habits of their pupils are an important means in attaining this effectiveness.

This book is designed to give teachers simple, direct, and sound help. It stresses the importance of both method and techniques. Both are important and one cannot be divorced from the other. Reading at all levels—pre-primer through high school is considered. Many practical suggestions are made for making effective use of reading readiness and to improve both comprehension and rate of reading. More stress is made on phonetics or word analysis than found in a number of recent books on reading and elementary education. This should prove a valuable book for many prospective and in-service teachers.

MEHL, MARIE A., MILLS, HUBERT H., AND DOUGLASS, HARL R. *Teaching in Elementary School.* New York: The Ronald Press Company, 1950. 541 p. $5.00.

This is a rather comprehensive treatment of the fundamental theory and practice of teaching in elementary schools. It is intended for both prospective and in-service elementary teachers. The authors conceive elementary education to encompass the all-round growth of children. The authors are teachers of experience, their combined experience covering most all aspects of elementary education from one-room rural schools to administrative work in large school systems.

The every day activities of teachers receives major stress. Objectives, principles of learning, motivation, selection, planning, directing, drill, review, questioning, evaluating, measuring, guiding, audio-visual aids, professional and in-service growth are each discussed at some length. At the end of the text is a list of selected readings, listed according to the various chapters in the text.

Prospective teachers and teachers using this book should attain a very good understanding of the purposes, methods, and techniques of elementary school education. Many practical suggestions are made for effective classroom teaching. Altogether this book may be recommended as one of the best books in elementary education.

MALVERN, GLADYS. *Tamar.* New York: Longmans, Green and Company, 1952. 211 p. $2.50.

Tamar is the only daughter of the rich and powerful ruler of Capernaum. The time of the story is the two or three years preceding and including the Crucifixion. The story is based on events and stories told in the Bible. The main theme of the story is true. Only the actual activities and sayings of the characters are in part fictionized. Tamar the daughter of Jairus was brought back to life by Jesus as He went about his ministry in Capernaum and Galilee. Tamar's faith and Jairus' eventual realization of the actual presence and the true significance of the Crucifixion are important highlights of the story. Altogether this is almost delightful story. Miss Malvern uses a literary style that grips and holds the attention of the reader. Manifest in her earlier story based on events in the Bible, *Behold Your Queen,* her unusual ability to write great stories for young people is more evident in *Tamar.*

REIDMAN, SARAH R. *Your Blood and You.* New York (20 East 70th Street): Henry Schuman, Inc., 1952. 130 p. $2.50.

This book intended for the layman or as a popular book for teen-agers is one of the few that have been written in this particular area. The author uses a most readable literary style in presenting the story of blood. All sorts of superstitions and wrong ideas about blood have been held by people up to the relatively recent past. Some of these misconceptions are still prevalent in this country among the ignorant and some of the not-so-ignorant. Blood-letting was a scientific practice among physicians not so long ago.

The author presents considerable material about the contributions made by various scientists to our knowledge of what the blood is, how it circulates, and its real functions in human beings: how it clots, what gives it color, what moves it around the body, how it carries food and oxygen, how it protects the body against disease, the need and value of transfusions, the different types of blood, and so on.

Dr. Reidman teaches physiology at Brooklyn College. She is a well known science writer, including a college text in physiology and the unusually fine teen-age books *How Man Discovered His Body* and *Water for People.* The reviewer recommends this book highly for the high school science library, as a supplementary reader for the biology student, and as a fine source book for elementary teachers.

MCBRIDE, H. A. *Trains Rolling.* New York: The Macmillan Company, 1953. 269 p. $5.00.

Not only are most boys interested in seeing, reading about, and looking at pictures of trains, but the same is true of many men and even some

college professors the reviewer has known. In fact two of the most enthusiastic train lovers and authorities in this country are college professors. This is a book for all such persons written by a hobbyist and authority on railroads. This book, illustrated by 237 photographs taken by the author, is based on first-hand observations.

Much of America's industrial progress has been based on the development of its vast and unexcelled railroad facilities. And even today we are far more dependent upon railroads than most people realize. Railroads are typically American.

Many famous American railroad lines, trains and locomotives are described in this book—many eastern and southern lines. Also there are chapters on the railroads of Morocco, Germany, and Spain. Altogether, *Trains Rolling* is an unusually fine book that will appeal to all persons having railroads as a hobby or interest.

BENTEL, PEARL BUCKLEN. *Program for Christine* New York: Longmans, Green and Company, Inc., 1953. 249 p. $2.75.

Although fictional in character portrayed, *Program for Christine* is an intensely interesting description of what goes on in a fairly large independent radio broadcasting station.

Unable to go to college after high school graduation, Christine obtains a position with radio station WISO. Ambitious to become a radio script writer, Christine soon finds she really knows almost nothing about either what goes on in a broadcasting station or the nature of the various types of writing used in the varied programs and announcements.

But willing to start at the bottom as a "flunkey," Christine slowly learns the countless details of radio business and to a most satisfying degree attains a part of her ambitions. She writes two quite successful radio plays.

The descriptive accurate account of the countless details essential in radio broadcasting makes this book an excellent addition to the "Career" shelf of the high school library. Written in this fictional setting, the book is more likely to appeal to many high school boys and girls than a more prosaic account of radio work.

LEWIS, ROGER. *Stamp Collecting.* New York: Alfred A. Knopf, 1952. 44 p. $1.50.

Stamp Collecting is a beginner's book on a very important hobby that may start at any period of life.

The first postage stamp was issued in England in 1840, certain American cities in 1840, and by the Federal Government in 1847. Many boys and girls start this hobby quite young. It is one of the finest hobbies a young boy or girl can have, and is very educational at the same time. This book should be suitable for third graders on up.

Illustrated with many line drawings and photographs, there is material telling how to start a collection, preparing stamps, sorting stamps, identifying stamps, how to handle stamps, different kinds of stamps, and terms used in stamp collecting.

This is a fine book for all boys and girls who are or might become interested in what could prove to be a most interesting life-time hobby. It is a good book for the elementary school book shelf.

VAN RENSSELAER, ALEXANDER. *Magic.* New York: Alfred A. Knopf, 1952. 44 p. $1.50.

Magic is a book that will appeal to most boys and many girls, too. It is suitable for youngsters of seven years up and the tricks described have been selected for elementary school level. Twenty-five "tricks" are described and illustrated. There are coin tricks, card tricks, "mind-reading," ropes, handkerchiefs, disappearing tricks with different objects, a magic wand, and so on.

Youngsters will spend hours of time and much energy to "master" these tricks, to put on at a school assembly, to mystify their parents and friends. This is an excellent hobby book for elementary school youngsters and for the elementary school book shelf. It is doubtful if the book will ever be found on the book shelf, if there is any possible excuse a youngster can give to have it checked out.

FOX, HELEN M. *The Years In My Herb Garden.* New York: The Macmillan Company, 1953. 185 p. $3.95.

The author says herbs are the most romantic of plants, the richest in folklore, and among the most entrancing with which to build a garden. One who reads this stimulating book will heartily agree with Mrs. Fox. Undoubtedly the use of herbs in American gardens has been sadly neglected. They offer so much of beauty, fragrance, and contentment that a wider use of herbs is to be very much desired.

Mrs. Fox is so enthusiastic about herbs that most readers of her book will be stimulated to initiate a herb garden of their own. This would be a most fortunate occurrence. The reviewer remembers with pleasure the many herbs in his grandmother's garden when he was a boy. Herbs in garden are much less in evidence now but possibly books like this and people like Mrs. Fox can reverse the trend.

Mrs. Fox for more than thirty years has had a herb garden of her own, designed a number for other people, and written extensively in the field. *The Years in My Herb Garden* brings together much material that has been unavailable except in scattered publications or actually not previously in print.

She lists the various herbs by scientific and common names, describes them, discusses something of their history, geographical distribution and uses. More than 300 varieties of herbs are grown in her own garden. Altogether, this is a delightful book to read and have.

PATTERSON, MARGARET E. AND KRAUS, JOSEPH H. *Thousands of Science Projects.* Washington, D. C.: Science Clubs of America, Science Service, 1953. 44 p. $0.25.

This is a compilation of thousands of items for research and experimentation done by students in preparation for the National Science Talent Search (started in 1942) and the National Science Fair (started in 1950). This publication was made possible by a grant from the National Science Foundation.

Titles of projects and exhibits have been compiled and classified according to a modification of the Library of Congress system so that the booklet can also be used as a guide to library sources in the subject areas. There are eight pages of illustrations which show how projects look when they are completed.

Junior high school and senior high school teachers and science club sponsors as well as pupils at these levels and in these clubs will find this publication one of the most useful of publications through many years to come. It would be very fortunate if it could be assumed every American science teacher at these levels and every science club sponsor had a personal copy of *Thousands of Science Projects.*

RAWLS, ROBERT. *Time Out for Mental Digestion.* Scarsdale, New York: The Updegraf Press, Ltd. 45 p. $1.00.

The subtitle for *Time Out for Mental Digestion* is *The Cure for One of Our Greatest Weaknesses in Dealing with People.* As with food, people need time to mentally digest ideas. Some people take or need longer periods of time for this process of mental digestion than others. Interesting, concise, practicable suggestions are made in this brochure for dealing more effectively with people in groups or individually. The author offers a six-point formula:

1. Predigest your ideas and plans as completely as you can before presenting them to any one.
2. Expect resistance. Welcome it instead of resenting it.
3. Launch your ideas and plans as far ahead as possible of the day or hour when decision or action will be required.
4. So far as possible stimulate an appetite for your ideas by "sampling" them informally in advance of the time for formal consideration.
5. Be painstaking in presenting your ideas and patient while others are digesting them.
6. Even after a plan or program has been agreed upon, do not expect miraculous progress over night; instead establish in your own mind a reasonable time period for its assimilation by the people involved.

Do more listening and less talking. Going for a walk alone is a great aid to mental digestion. This brochure has been used extensively by a great number of large business concerns. It offers much of value to teachers and school administrators.

PIKE, ROYSTON. *Round the Year With The World's Religions.* New York: Henry Schuman, Inc., 1950. 208 p. $2.50.

The months and seasons of the year have been invested by a wealth of fact and myth originating in the religious instincts of mankind. Chronologically, month by month, the author lists the various days and events of significance among most of the peoples of the world. The author presents the event or myth that led to that particular celebration.

Strangely enough most of our celebrations even of seemingly very religious nature such as Easter and Christmas have much of a pagan aspect. Other days are wholly pagan in origin. Of course, some are not religious in origin such as Fourth of July and Armistice Day.

The author traces the origins and describes the religious days not only in English speaking countries but other countries of the world as well. He explains why we color and eat eggs at Easter, duck for apples on Halloween, give gifts at Christmas, and so on. Many of the things people do originated in mythical reasons not now clearly understood.

Altogether this is a most interesting book that explains the various religious days 'round the year.